PART

one

An Overview of the Market

CHAPTER **1**

A Concise Guide to Mortgage-Backed Securities (MBSs)

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This chapter provides an introduction to mortgage securities and methods of analyzing them. While it lays the groundwork for the more detailed treatment of various topics in the rest of this book, it can also be used as a concise but comprehensive overview of the market for nonspecialists. The chapter is organized as follows:

- Section 1.1 describes the growth of the market.
- Section 1.2 reviews key features of agency mortgage pass-through securities, the most basic and most prevalent type of MBS.
- Section 1.3 discusses the basics of MBS analysis, such as prepayment estimation and modeling, and spreads over Treasuries.
- Section 1.4 describes option-adjusted spread methodology, which has become the standard way of evaluating MBSs.
- Section 1.5 gives an overview of structured MBSs, such as collateralized mortgage obligations and interest-only MBSs.
- Section 1.6 provides an introduction to the various types of non-agency MBSs.
- Section 1.7 gives a brief review of mortgage securitization outside the United States.

1.1 GROWTH OF THE SECONDARY MORTGAGE MARKET

The mortgage-backed securities (MBSs) market has experienced phenomenal growth over the past 20 years. The total outstanding volume of MBSs

EXHIBIT 1.1   Relative Size of U.S. Debt Sectors (Dollars in Trillions)

All Mortgage Debt	$6.32
Single-Family Mortgage Debt	4.76
Mortgage-Backed Securities	2.95
Treasury Securities	3.65
Corporate Bonds	2.06
Agency Debt	1.95

Note: Total for Treasuries includes Bills, while the total for Mortgage-Backed Securities includes those backed by nonresidential loans and home equity loans.
Source: Federal Reserve Bulletin, pp. A35 and A40, May 2000.

has increased from about $100 billion in 1980 to about $3 trillion, and as Exhibit 1.1 shows, mortgage-backed securities form a major component of the U.S. bond market.

Exhibit 1.2 shows a breakdown of Salomon Smith Barney's U.S. Broad Investment Grade (BIG) Index. Note that MBSs are a bigger proportion of the index than suggested by Exhibit 1.1, as almost half of all Treasury securities are Bills with maturities less than one year, and are hence excluded from the index.[1]

What accounts for the rapid growth of the MBS market? Increased securitization of mortgages and ready acceptance of MBSs by fixed-income investors are both key reasons. Mortgage originators became much more disposed to sell loans into the secondary market after the high-interest-rate environment of the late 1970s and early 1980s, when the disadvantages of holding fixed-rate long-term loans in their portfolios became apparent. The growing market share of mortgage bankers, who have little interest in holding onto mortgage loans, also has contributed to the increasing securitization of mortgages. In addition, many institutions have increasingly come to view securitization as a means of turning illiquid assets into liquid securities, and hence a tool for efficient balance sheet management.

The federal government has played an equally important role. Three agencies, the Government National Mortgage Association (Ginnie Mae), the Federal National Mortgage Associations (Fannie Mae), and the Federal Home Loan Mortgage Corporation (Freddie Mac) are major players in the

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[1] Also excluded are various mortgage sectors, such as non-agency MBSs, and various corporate bond issues. See *Salomon Smith Barney Global Index Catalog—1999* edition, February 1999.

EXHIBIT 1.2 Breakdown of Salomon Smith Barney's U.S. Broad Investment Grade (BIG) Index (Dollars in Trillions)

Sector	Par Amount	% of Index
Treasuries	$1.634	29.1 %
MBSs	1.895	33.8
Coroporates	1.408	25.1
Agency Debt	0.627	11.2
BIG Index	$5.607	100.0 %

Source: Salomon Smith Barney, May 2000.

secondary mortgage market in issuing and guaranteeing MBSs.[2] These federal housing finance agencies were created to facilitate the flow of mortgage capital and, hence, to ensure that lenders have adequate funds to make new mortgage loans. The three agencies are generally credited with significantly reducing the cost of mortgage borrowing for American home buyers, as well as making mortgages more widely available. On the demand side, MBSs have come to represent a significant portion of fixed-income holdings for many types of investors over the past decade. In Exhibit 1.3 we show a breakdown of holdings of MBSs by investor type.
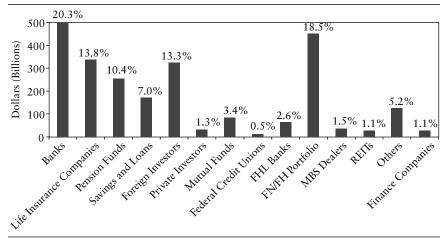
Why Institutional Investors Buy Mortgage Securities

MBSs have quickly become popular fixed-income investments for many reasons, including:

■ *Higher returns.* MBSs typically yield 100bp (basis points) or more over Treasuries and offer higher yields than comparable-quality corporate bonds. Although some of this higher yield compensates for their complexity and embedded prepayment options, MBSs still have outperformed comparable Treasuries and other corporate bonds in most years since the early 1980s, as shown in Exhibit 1.4.
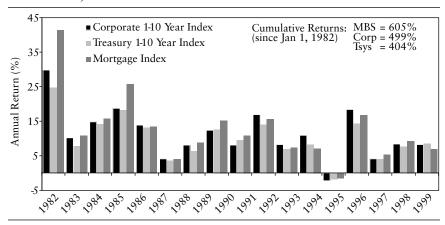
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[2] As discussed in the Introduction, although all three entities are commonly referred to as agencies, only Ginnie Mae is now a true agency. Fannie Mae, which the government established in 1938, and Freddie Mac, which Congress created in 1970, are now private entities, although both have strong ties to the government. The market convention is to refer to all three as agencies (although *Government Sponsored Enterprises* [GSEs] is becoming a more common term for Fannie Mae, Freddie Mac, and other such entities), and we will follow this convention.

EXHIBIT 1.3   Mortgage-Backed Securities—Holdings by Investor Type

Note: Numbers shown at the top of the bars are holdings as a percentage of total outstanding MBSs, as of midyear 1998. Note that the total may not add up to the same as in Exhibit 1 because certain types of MBSs, such as those backed by nonresidential loans, are not included here. *Source: Inside MBS and ABS,* Salomon Smith Barney.

EXHIBIT 1.4   Mortgage, Corporate, and Treasury Securities—Historical Performance, 1982–1999

Source: Salomon Smith Barney Fixed-Income Index Group.

Exhibit 1.4 also shows cumulative returns on various Salomon Smith Barney fixed-income indices; MBSs have outperformed Treasuries and corporate bonds by substantial margins. Even during the 1990s, when conditions were ideal for Treasuries and corporate bonds—falling interest rates and a sustained recovery from the early 1990s recession—and the environment tough for MBSs, with several major refinancing waves, MBSs still did relatively well versus comparable fixed-income instruments.

■ *Credit quality.* Ginnie Mae MBSs are backed by the full faith and credit of the U.S. government and, hence, like Treasuries, are considered to carry no credit risk. Fannie Mae and Freddie Mac MBSs do not have U.S. government guarantees, but because of Fannie Mae's and Freddie Mac's close ties to the government, their MBSs are perceived to have minimal credit risk and do not seem to trade at a noticeable credit premium to Ginnie Maes. MBSs from other (private) issuers typically carry AAA or AA ratings from one or more of the credit rating agencies.

■ *Choice of investment profiles.* Given the variety of MBSs created, this sector provides a wider range of investment characteristics than most other parts of the fixed-income market. For example, MBSs are available with negative, short, or very long duration. Prepayment sensitivities can range from low to very high. Coupons can be fixed (from 0% to more than 1,000%) or floating (directly or inversely with a range of indices).

■ *Liquidity.* The amount of outstanding MBSs, trading volume (second only to U.S. Treasuries), and the involvement of major dealers provide an active, liquid market for most MBSs.

■ *Development of analytic tools.* Since the mid-1980s, many major dealers (and some buy-side firms) have devoted considerable resources to developing analytic models for evaluating MBSs. These efforts have led to a better understanding of mortgage cash flows and a higher level of comfort with the characteristics of mortgage securities.

1.2 AGENCY PASS-THROUGH SECURITIES

The basic mortgage-backed security structure is the pass-through. As the name implies, a pass-through passes through the monthly principal and interest payments (less a servicing fee) from a pool of mortgage loans to holders of the security. Thus, investors in the pass-through are, in effect, buying shares of the cash flows from the underlying loans. Structured MBSs, such as collateralized mortgage obligations (CMOs) and interest-only (IO) and principal-only (PO) stripped MBSs (or STRIPs), carve up mortgage cash flows in a variety of ways to create securities with given prepayment and

maturity profiles. In this section we discuss pass-throughs; we describe structured mortgage securities (agency and non-agency) later in this chapter.

Development of the Pass-Through Market

The pass-through is the most common structure for mortgage-backed securities. A pass-through issuer acquires mortgages either by originating them or by purchasing them in the whole-loan market. Many mortgages with similar characteristics are collected into a pool, and undivided ownership interests in the pool are sold as pass-through certificates. The undivided interest entitles the owner of the security to a pro rata share of all interest payments and all scheduled or prepaid principal payments.

The growth of the pass-through market stems in large part from the active role of the U.S. housing finance agencies in the primary and secondary mortgage markets. Ginnie Mae, Freddie Mac, and Fannie Mae account for nearly all of the issuance and outstanding principal amount of mortgage pass-throughs.

The programs of the three major federal housing agencies reflect the historical development of U.S. housing policy. Fannie Mae was created in 1938 as a wholly owned government corporation. Its charter mandated that it purchase Federal Housing Administration (FHA)-insured and, (since 1948), Veterans Administration (VA)-guaranteed mortgages for its portfolio.[3] Congress intended to ensure that mortgage lenders would continue to be able to make residential mortgage loans, even in periods of disintermediation (when withdrawals by depositors are high) or when delinquencies and defaults are high. Fannie Mae's purchase activities encouraged the standardization of repayment contracts and credit underwriting procedures for mortgages.

In 1968, the government restructured its role in the housing finance market. Fannie Mae was privatized, although it retained its mandate to buy FHA/VA loans for its own portfolio. **Ginnie Mae** was spun off as a separate agency that would undertake some of Fannie Mae's previous activities; in particular, Ginnie Mae assumed the financing of home loans not ordinarily underwritten in the established mortgage market, such as loans to low-income families. Ginnie Mae's most important activity has been its mortgage pass-through program, which was instituted in 1970. Under this program, Ginnie Mae guarantees the payments of principal and interest on pools of FHA-insured or VA-guaranteed mortgage loans.

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[3] The FHA and the VA are U.S. government entities that provide mortgage insurance intended to serve low and moderate-income home buyers.

The enhanced availability of credit to home owners who qualify for FHA and VA loans led to calls for similar treatment for nongovernment-insured (or *conventional*) mortgages. In 1970, Congress established Freddie Mac to develop an active secondary market for conventional loans, and in 1972, Fannie Mae began to purchase conventional mortgages. Thus, by 1972, lenders could sell their newly originated conventional mortgages to either Fannie Mae or Freddie Mac.

Freddie Mac issued a small volume of pass-throughs in the 1970s, while Fannie Mae began its MBS program in late 1981. As Exhibit 1.5 indicates, issuance volume from all three agencies increased tremendously in the 1980s, hit a peak in the refinancing waves of 1993, and recently hit record levels with the heavy volume of refinancing in 1998.

TERMINOLOGY

Exhibit 1.6. provides a description of a fairly typical mortgage pass-through, or pool, including key current pool characteristics which are updated each month by the agencies (through electronic tapes called *pool factor tapes)* for their pools (for non-agency MBSs, issuers provide updated tapes for their deals each month).

Ginnie Mae guarantees timely principal and interest payments on all of their pools. On Fannie Mae and Freddie Mac pools, the respective agencies guarantee principal and interest payments to investors. Private-label MBSs,
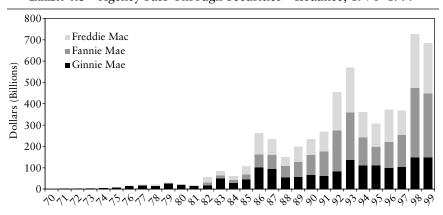
EXHIBIT 1.5 Agency Pass-Through Securities—Issuance, 1970–1999

Source: Inside MBS and ABS.

EXHIBIT 1.6   Ginnie Mae Pool 301100

Issue Date:	03/01/1991	**Delay:**	45 Days
Collateral:	30-Year Fixed-Rate Loans	**Original Balance:**	$3,258,373
Net Coupon:	9.00%	**WAC:**	9.50%
Current Balance:	$341,431		
Factor:	0.10478598		
WAM:	20-05 Yrs.		
WALA:	9-04 Yrs.		

WAC: Weighted-average coupon, WALA: Weighted-average loan age, WAM: Weighted-average maturity.
Note: Current balances, Factor, WAM, and WALA as of June 8, 2000.
Sources: Ginnie Mae and Salomon Smith Barney.

which the rating agencies typically rate triple-A, are issued with various forms of credit enhancement, based on rating agency requirements.

Exhibit 1.6 also shows some of the terminology and information used to analyze MBSs:

■ **Net coupon and WAC.** The net coupon of 9% is the rate at which interest is paid to investors,[4] while the weighted-average coupon (WAC) of 9.5% is the weighted-average coupon on the pool of mortgages backing the pass-through. The difference between the WAC and the net coupon is called the **servicing spread.** The majority of Ginnie Mae pools are issued under the so-called **Ginnie Mae I** program, and for such pools, the underlying mortgage loans all have the same note rate (9.50% for the pool in Exhibit 1.6) with a servicing spread of 50bp. Pass-throughs issued under an alternative program called **Ginnie Mae II**[5] and those issued by Fannie Mae and Freddie Mac allow for variations in the note rates on the underlying loans. In the latter case, the WAC could change

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[4] This is the annualized rate. Mortgage cash flows are monthly, so each month investors receive interest at a rate of $\frac{3}{4}$%; in other words, 0.0075 times the balance outstanding at the beginning of the month.

[5] The Ginnie Mae II program allows for multiple-issuer pools (i.e., loans from a number of different issuers are pooled—in contrast, Ginnie Mae I pools contain loans from a single issuer), as well as for different note rates on the underlying pools. The Ginnie Mae II program has become well established in recent years, with issuance running at about 30% of that of Ginnie Mae I. For a recent update on the Ginnie Mae II program, see *Bond Market Roundup: Strategy,* Salomon Smith Barney, December 12, 1998.

over time (as loans are prepaid), and hence, the latest updated WAC would be shown.

■ **WAM and WALA.** The weighted-average maturity (WAM) is the average (weighted by loan balance) of the remaining terms on the underlying loans, while the WALA is the weighted-average loan age. Note that the sum of the WAM and WALA in Exhibit 1.6 is (20-05 + 9-04), or 29-09. If the underlying loans had original terms of 30 years, why is this figure not 30 years exactly? There are two reasons: (1) some of the loans may have had original terms of less than 30 years (e.g., 25 years) because pass-throughs backed by 30-year loans in fact may have mortgages with any original term of greater than 15 years (although the majority of loans will typically have 30-year original terms); and (2) some mortgagors are in the habit of sending in extra monthly payments, above and beyond the scheduled monthly payment, to build up equity in their properties at a faster rate. These extra payments, often referred to as *curtailments* or as *partial prepayments* (as opposed to a full prepayment of the whole mortgage) shorten the remaining term until the mortgage is paid off because the monthly payment remains unchanged (for fixed-rate loans) while the balance to be amortized decreases. The WAM will reflect the extent of this shortening.

■ **Delays.** Cash flows are passed through to investors with a delay to allow servicers time to process mortgage payments. For the Ginnie Mae pool shown in Exhibit 1.6, the stated delay is 45 days, which means that the principal and interest for September, say, is paid on October 15, rather than on October 1. Thus, the actual delay is 14 days. Fannie Maes have a stated delay of 55 days, while FHLMC Golds have a stated delay of 45 days.[6] Of course, these delays are factored into calculations of returns to investors.

■ **Pool factor.** The Ginnie Mae pool in Exhibit 1.6 had a factor of 0.10478598 as of June 8, 2000. The factor is the proportion of the original principal balance outstanding as of the stated factor date. The factor declines over time because of scheduled principal payments (amortization) and prepayments. In this case, amortization alone would have reduced the factor by less than 10% since the pool was issued in 1991; thus, this pool clearly has experienced heavy prepayments. As we discuss in the next section, a comparison of the actual

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[6] Almost all Freddie Mac pass-throughs are issued now under its Gold program, which was started in 1990. Freddie Mac pass-throughs issued prior to the introduction of the Gold program have a delay of 75 days and, hence, are often labeled 75-day *Participation Certificates* (PCs).

factor with the factor under amortization alone is used to estimate pre-payment rates on mortgage pools.

TYPE OF AGENCY PASS-THROUGH COLLATERAL

In general, the agencies segregate loans into pools by the following categories:

■ Type of property (single-family or multifamily);
■ Payment schedule (*level, adjustable,* other);
■ Original maturity; and
■ Loan coupon rate.

Single-family loans, defined as loans on one- to four-family homes, provide the collateral for the great majority of agency pass-throughs. A brief description of agency multifamily programs is given later in this section. Here we review single-family collateral types.

Government and Conventional Loans

Loans insured by two U.S. government entities, the FHA and the VA, collateralize Ginnie Mae pools. Other loans are referred to as *conventional* loans. Conventional loans back almost all Fannie Mae and Freddie Mac pools, although both agencies have issued pools backed by FHA/VA loans.

Because of restrictions on loan size and lower downpayment requirements, FHA and VA borrowers tend to be less affluent than conventional borrowers, characteristics likely to lead to slower Ginnie Mae prepayment rates. However, because income levels and housing costs vary from region to region, certain regions have greater concentrations of FHA/VA loans. Hence, prepayment differentials between Ginnie Mae and Fannie Mae/Freddie Mac speeds can partly reflect regional housing market differences.

Conforming and Nonconforming Loans

Conventional loans may be segregated further into conforming and nonconforming loans. Conforming loans are those that are eligible for securitization by Fannie Mae and Freddie Mac, which means that the original loan balance must be less than the specified Fannie Mae/Freddie Mac limit (currently $240,000 and changed each year based on housing inflation) and that the loans must meet Fannie Mae/Freddie Mac underwriting guidelines (in terms of required documentation, borrower debt-to-income ratios, loan-to-value (LTV) ratios, etc.).

Nonconforming loans form the collateral for private-label MBSs. In most cases, these loans are nonconforming because they exceed the Fannie Mae/Freddie Mac loan size limit (jumbo loans). However, the sizes of a significant number of loans in private-label deals are below this limit, but are nonconforming because they do not meet Fannie Mae and Freddie Mac underwriting standards. An overview of non-agency MBSs is given in Part Six.

Payment Schedules and Loan Terms

Within each of these administrative categories, loans are further classified by payment type and term.

Fixed-Rate or Level-Pay Loans   These loans remain the basic collateral for pass-throughs. As the name implies, they are fully amortizing loans with fixed coupons and, hence, fixed monthly payments. The most popular loan term is 30 years, although 15-year loans appeal to those who want to build up equity faster in their homes and who can afford higher monthly payments. Smaller amounts of pass-throughs are backed by 20-year and 10-year loans, which were mainly issued as refinancing vehicles during the various refinancing waves of the past several years.

Adjustable-Rate Mortgages (ARMs)   ARMs became popular during the high-interest-rate period of the early 1980s. Since then, they have continued to account for a significant fraction of total mortgage originations. During periods of high fixed mortgage rates, as much as 60% of originations have been ARMs, but even when fixed rates are low, ARMs typically constitute at least 15% of originations. An explanation for their popularity is the low initial coupon (or teaser rate), that attracts borrowers (such as first-time home buyers) who want to minimize their starting monthly payments. After the teaser rate period is over, the coupon resets off a specified index, such as the one-year Treasury rate, subject to periodic caps (the maximum amount that the coupon can change at each reset date) and life caps (the upper limit on the ARM coupon). Securitization rates for ARMs are typically less than for fixed-rate loans, because some originators hold them in their portfolios.

A recent development is the **hybrid ARM.** As the name implies, a hybrid has features of both fixed-rate loans and ARMs: It has a fixed coupon for a specified number of years (typically three, five, seven, or ten), after which the coupon, as with a standard ARM, resets periodically off a specified index.[7]

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[7] See Chapters 9 and 10 for a more detailed discussion of ARMs and hybrid ARMs.

Balloon Loans Fannie Mae and Freddie Mac securitize these loans. The loans amortize according to a 30-year schedule, with a balloon payment due at the end of five or seven years. Balloon MBSs were first issued in late 1990 and were quite popular in the refinancing waves of 1992 and 1993, but have declined in popularity since then, partly because of the growing popularity of hybrid ARMs.

There are various other payment types, such as *graduated payment mortgages* (GPMs), which typically have lower initial monthly payments and higher subsequent ones relative to a standard fixed-rate loan. The idea behind these mortgages is to make it easier to purchase a home for first-time buyers. Such types are a fairly minor segment of the market nowadays.

In Exhibit 1.7, we summarize some of the key features of the main agency pass-through programs.

TYPES OF PASS-THROUGH TRADING

Most agency pass-through trading is on a **to-be-announced (TBA)** basis. In a TBA trade, the buyer and seller decide on general trade parameters, such as agency, coupon, settlement date, par amount, and price, but the buyer typically does not know which pools actually will be delivered until two days before settlement. The seller is obligated to provide pool information

EXHIBIT 1.7 Through Programs—Characteristics

	Ginnie Mae	Fannie Mae	Freddie Mac
Types of Mortgage	FHA/VA	Conventional (Some FHA/VA)	Conventional (Some FHA/VA)
Guarantee	Timely payment of interest and principal	Timely payment of interest and principal	Timely payment of interest and principal
Guarantor	US Government	Fannie Mae	Freddie Mac
Amount (in Billions)			
• **Issued to Date**	$1,282	$1,674	$1,642
• **Currently Outstanding**	537	785	633
Main Collateral Types and Amounts Outstanding (in Billions)	**30 Yr. F-R Ginnie I:** $356 **Ginnie II:** $69 **15 Yr. F-R Ginnie I:** $23 **Ginnie II:** $1 **ARMs:** $79 **Projects:** $9	**30 Yr. F-R:** $533 **15 Yr. F-R:** $164 **Balloons:** $22 **ARMs:** $35 **Multifamily:** $31	**30 Yr. F-R:** $444 **15 Yr. F-R:** $146 **Balloons:** $18 **ARMs:** $24 **Multifamily:** $1
Servicing Spread	Ginnie Mae I: 50bp Ginnie Mae II: 50bp-150 bp	Up to 250bp, but typically 40bp-80bp	Up to 250bp, but typically 40bp-80bp
Delays (Days)			
• **Stated**	45 (Ginnie II: 50)	55	45
• **Actual**	14 (Ginnie II: 19)	24	14

ARMs: Adjustable-rate mortgages, bp: Basis points, BLNs: Balloons, FHA: Federal Housing Authority, F-R: Fixed-Rate, VA: Veterans Administration.
Notes: For Freddie Mac, delay shown is for Gold PCs; older PCs issued before the Gold program have a 75-day delay. Data as of February 1999.
Sources: Ginnie Mae, Freddie Mac, Fannie Mae, and Salomon Smith Barney.

by 3 P.M. two days prior to settlement (the 48 Hours Rule). The pools delivered are at the discretion of the seller, but must satisfy *Good Delivery* guidelines established by the Bond Market Association, a trade group representing bond dealers (formerly known as the Public Securities Association, or PSA). Good Delivery guidelines specify the allowable variance in the current face amount of the pools from the nominal agreed upon amount,[8] the maximum number of pools per $1 million of face value, and so on.

The TBA market facilitates liquidity in pass-through trading because most individual pass-through pools are small. Almost all newly issued pools trade as TBAs. Most price quotes shown for pass-throughs, and valuation analyses such as those in the next section, are for TBA coupons. Such pricing and analysis assume WACs and WAMs based on an estimate of what is most likely to be delivered at the time.

Pass-Through Vintages

Investors also can specify a particular loan origination year (or vintage, sometimes also referred to as a specific WAM) when buying a block of pass-throughs. For example, whereas a TBA trade might be for $100 million of 30-year Ginnie Mae 7s, a vintage trade might specify $100 million of 1993 30-year Ginnie Mae 7s. The investor would then receive Ginnie 7% pools collateralized by loans originated in 1993. Because the 1993 Ginnie 7s may have favorable prepayment characteristics relative to new production (e.g., more burnout or more seasoning), they would typically sell at a premium to TBAs. This blended market has become much more active in the past few years.[9]

Specified Pools

A large and active market also exists in specified pools, in which buyers know exactly which pools they are buying, and, hence, relevant characteristics such as WAC, WAM, age, prepayment history, and so on. With this

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[8] Because the face amount of the pools could be any arbitrary amount (e.g., $341,431 in the example in Exhibit 1.6), it will generally be difficult to obtain pools whose outstanding amounts sum *exactly* to the agreed upon trade amount. Hence, some variance is allowed in the amount delivered. This variance was as one time 2% from the agreed upon amount, then 1%, and currently the BMA is in the process of implementing even tighter variances.

[9] For readers with access to Salomon Smith Barney's Yield Book® system or to SSB Direct, report MB712 gives market and theoretical prices for TBAs and specified origination year pass-throughs.

extra degree of certainty, specified pools typically trade at a premium to comparable TBA coupons.

Story Bonds   While most trading in specified pools involves fairly seasoned bonds, a recent development is the trading of new pools with specific prepayment characteristics. Some examples include:

- *Prepay penalty pools,* which are backed by loans that carry a penalty (typically about six months of interest) if the loan is refinanced within the first three or five years.
- *Low WAC pools,* which are pools with WACs lower than the typical TBA average. For example, conventional TBA 7s currently are assumed to have a WAC of 7.60%, so 7% pools with a WAC of, say, 7.40% will trade at a premium to TBA 7s.
- *Low loan balance pools,* which are backed by "smaller than average" loans. Because refinancing costs are more of a hurdle for such loans and because smaller loan balances can imply less affluent borrowers, then other things being equal, such loans may prepay more slowly than average.

Combined Pools

Freddie Mac Giant PCs and Fannie Mae MegaPools, introduced in mid-1988, and Ginnie Mae Platinum pools, introduced in late 1994, are mortgage pass-throughs that the agencies create by combining already outstanding pass-throughs. Such pools benefit investors who own small pass-through pools or seasoned pools that have paid down. These investors can swap their holdings for a pro rata share of a new Giant PC, MegaPool, or Platinum pool. Similarly, these programs help lenders design more marketable securities. Lenders can take recently securitized smaller pools that are still held in portfolio and aggregate them into a bigger pool.

From the investor's perspective, large pools provide the following advantages in addition to greater liquidity:

- *Greater diversification.* When the combined pool is backed by pass-throughs from many investors, the geographic distribution of the underlying mortgages is typically greater. This diversification reduces the risk of random prepayment and default variations. Thus, the prepayment rates of combined pools would follow average mortgage sector prepayment rates more closely than would most standard pools.
- *Lower administration costs.* Investors can track the monthly payments and balances for a few large pools more efficiently than they can for a greater number of small pools.

■ *Lower reverse repurchase rates.* Investors can achieve lower financing rates when entering into reverse repurchase agreements by pledging bigger pools. Securities dealers and banks often pass on the administrative cost savings of larger pools to the customer.

MULTIFAMILY PASS-THROUGH PROGRAMS

Although small in comparison to the single-family MBS sector, pass-throughs backed by multifamily mortgages comprise a sizable market as shown in Exhibit 1.7. Fannie Mae and Freddie Mac have securitized multi-family loans (defined as mortgages on five or more family homes) for many years, and their programs have gone through various revisions over the years. Investors should note some common features of multifamily MBSs:

■ Many multifamily loans have **prepayment penalties,** giving the investor a degree of call protection. The penalty is often in the form of *yield maintenance*; thus, the amount of the penalty depends on the decline in interest rates since issuance. The objective is to fully compensate the investor for the prepayment.
■ Many multifamily loans have balloon payments due, with the balloon date typically occurring between 5 and 15 years.

Project loans is a term that refers to FHA-insured mortgage loans made on a variety of property types such as multifamily housing, nursing homes, and hospitals. The loans are either securitized as Ginnie Mae pass-throughs or sold as FHA PCs. Project loans typically have prepayment penalties. In addition, some project loans are putable; in other words, the investor has the option of selling the bond to the issuer for a specified price at specified times.

Multifamily pass-throughs and project loans are special cases of MBSs backed by **commercial real estate** loans. Commercial mortgage-backed securities (CMBSs) combine the features of standard MBSs with those of callable corporate bonds and are further discussed in Part Six.

1.3 BASICS OF MORTGAGE SECURITY ANALYSIS

In this section, we discuss the basics of MBS analysis, starting with prepayments. Standard bond valuation measures, such as yield spread, are also described. Although the dependence of mortgage cash flows on interest rates (through prepayments) makes traditional bond analysis of limited use for MBSs, such analysis is still a useful starting point.

Measuring Prepayments

Prepayments are calculated by comparing actual principal received with scheduled principal; the difference is the prepaid principal. The convention is to state prepayment rates in terms of the outstanding principal balance (as opposed to, for example, the initial balance). Observed prepayment rates can be stated in one of several different units.

Single Monthly Mortality (SMM) This refers to the prepayment rate for a month and forms the basis for all prepayment calculations. The SMM is the fraction of the beginning-month balance that prepays during the month; by convention, the scheduled principal is subtracted from the balance before calculating the prepayment rate. (The SMM is defined mathematically in Equation D1 in Appendix D). For example, if the principal balance at the beginning of a month is $100, scheduled principal is $0.5, and total principal received is $1, then prepaid principal equals $0.5, and the SMM is $0.5 divided by ($100 − $0.5), or 0.5/99.5, which is 0.5025%.

Constant Prepayment Rate (CPR) The CPR is the annualized version of the SMM; that is, it is the cumulative prepayment rate over 12 months given the same SMM each month. It is given by Equation D2 in Appendix D for small SMM (less than a few percent), the CPR is approximately 12 times the SMM.

Public Securities Association (PSA) Convention The PSA benchmark curve was introduced in the mid-1980s to account for the seasoning (or aging) pattern typically observed with MBSs; new loans tend to have low prepayment rates, which gradually increase until the loans are seasoned. The PSA measurement convention adjusts the CPR for age, as shown in Exhibit 1.8. The base PSA curve, or 100% PSA, assumes the prepayment rate starts at 0% CPR at age 0 and increases by 0.2% CPR per month until month 30, after which the speed is a constant 6% CPR. A rate of 50% PSA means that the CPR in any month is half that implied by 100% PSA. A rate of 200% PSA means that the CPR in any month is twice that implied by 100% PSA, and so on. Formulae for converting from CPR to PSA, and vice versa, are given by Equations D3 and D4 in Appendix D. Prepayment speeds are rarely stated in SMMs. Instead, the speed is stated either in its annualized form (CPR), or in PSAs (which can be thought of as an age-adjusted CPR).

Which Is Preferable, CPRs or PSAs? Investors should note that CPRs and PSAs are just different units for expressing a prepayment rate. Hence, provided we understand what the units are, it does not matter whether a given

EXHIBIT 1.8 The PSA Prepayment Convention

CPR: Constant prepayment rate.
Source: Salomon Smith Barney.

month's speed is stated as a CPR or as a PSA; both will translate into the same MBS cash flow.

The question becomes meaningful, however, if the loans are relatively new, and we are using actual speeds to assess likely future speeds. In this case, each method makes assumptions about the effect of age on speeds. The CPR in effect assumes no seasoning ramp: A CPR of 3% remains the same whether the loans are 10 months old or 100 months old. The PSA curve makes an explicit seasoning assumption: The speed is adjusted as if seasoning occurs at a linear rate over 30 months. Hence, a CPR of 3% at loan age 10 months is assumed to be equivalent to 9% CPR for loans more than 30 months old.

The PSA convention would be preferable if loan seasoning did take place as specified by the PSA ramp. However, while the PSA curve is based on historical data—average prepayment speeds on seasoned discount FHA loans have been around 6%, and mortgages in the past have seasoned over about 30 months—the data (the so-called FHA experience) is old, and seasoning patterns are now often quite different from the PSA assumption. For example, new premiums can prepay at rates of 30% CPR or more, which can translate into PSAs in the thousands. A PSA of 4,000% is clearly useless for assessing likely future speeds. However, a CPR of 1% on a new discount is equally lacking in predictive value.

To summarize, it does not matter whether CPRs or PSAs (or SMMs, for that matter) are used as prepayment measurement units. However, for new securities, we should be careful about extrapolating forward from actual CPRs or PSAs. For such securities, projected cash flows should be obtained
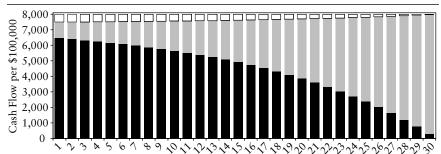
EXHIBIT 1.9 Ginnie Mae 6.5% Cash Flows with No Prepayments

Source: Salomon Smith Barney.

using a vector of projected monthly speeds, with the projections incorpo-
rating the expected seasoning pattern of the MBS.[10]

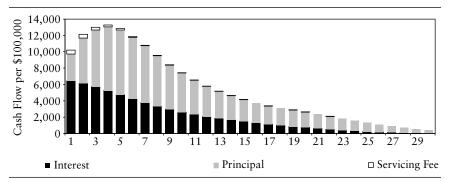### The Effect of Prepayments on MBS Cash Flows

Exhibit 1.9 shows the cash flows from a new Ginnie Mae 6.5% in the (un-
likely) case of zero prepayments; that is, all the underlying loans survive the
full 30-year original term. Although the total monthly payment from the
underlying loans is constant, the payment to the Ginnie Mae 6.5% holders
is the total payment *minus* a servicing spread of 50bp; that is, the mort-
gagors pay a 7% coupon, while the Ginnie Mae investors receive a 6.5%
coupon. Hence, the servicing amount is proportional to the remaining prin-
cipal balance and declines as the remaining balance declines.

In practice, all MBSs will experience some prepayments. Exhibit 1.10
shows the Ginnie Mae 6.5% cash flows if prepayments occur at a constant
rate of 100% PSA.

While actual speeds will vary from month to month, Exhibit 1.10 does
give a good representation of the likely cash flow pattern from an MBS,
with principal payments and total cash flows peaking and then declining
over time, as the principal balance declines.

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[10] Note that if a vector of monthly projections, such as the one generated by Sa-
lomon Smith Barney's prepayment model, is used to obtain projected MBS cash
flows, the results will be the same whether the vector is stated in CPRs or PSAs.

EXHIBIT 1.10 Ginnie Mae 6.5% Cash Flows at a Constant Prepayment Rate of 100% PSA

Source: Salomon Smith Barney.

A Brief Primer on Prepayment Analysis and Modeling

Prepayment projections are fundamental in valuing MBSs. We have published a comprehensive discussion of prepayment behavior in Chapter 4.[11] Here we briefly describe the main factors that influence prepayment rates.

Prepayments occur for several reasons, the most important of which are **home sales** and **refinancings.** Minor causes include **defaults,** which typically average less than 0.5% CPR, and **curtailments** or **partial prepayments,** referring to mortgagors' paying more than the scheduled payment each month to obtain a faster equity buildup. Like defaults, curtailments are typically low (less than 0.5% CPR), although some evidence exists that they are higher for very seasoned loans. When the loans are very seasoned and the remaining balance is small, some mortgagors may pay off their mortgage in full. (Full payoffs can also occur because of the destruction of the home from natural disasters such as hurricanes and earthquakes.)

Home Turnover   The sale of a home in the United States typically leads to an attached mortgage being paid off.[12] Hence, prepayment rates on discount mortgages will depend on the turnover rate of existing homes. This rate has recently been running at around 7% per year, although the historical average

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[11] See Chapter 4 for a detailed discussion of prepayments.

[12] The main exceptions are FHA and VA loans (the collateral for Ginnie Maes), which are assumable by the buyer of the house. However, except for new deep discount loans, few such mortgages are assumed, due to the expense of obtaining a second mortgage on top of the existing one.

is closer to 6%. Thus, 6% to 7% CPR can be considered an average overall baseline prepayment rate for discount mortgages. However, the prepayment rate for discounts will depend on several factors:

■ Housing turnover rates will depend on mortgage rates and the general state of the economy. In addition, U.S. home sales have a pronounced seasonal pattern, with summer sales almost double those in the winter.
■ Newer discount MBSs tend to have lower speeds than seasoned ones, because people typically do not change homes again soon after moving. The length of this **seasoning period** will depend on various factors, such as the difference between the current loan rate and prevailing rates, housing inflation and resulting equity buildup in the house, and loan type. FHA/VA loans are assumable, a characteristic that reduces the speeds on newer deep-discount Ginnie Maes and, in effect, lengthens the seasoning period.
■ Because speeds on newer discounts will be much lower than on seasoned ones, speeds on seasoned discounts will be higher than the 6% to 7% average.
■ Conventional (Freddie Mac/Fannie Mae) loans historically have somewhat higher turnover rates than FHA/VA (Ginnie Mae) loans, although the difference partly depends on the relative strengths of regional housing markets.[13]
■ If a particular MBS has a concentration of loans in a particular geographic area (e.g., predominantly in California), speeds can vary from the average.
■ As indicated earlier, defaults and curtailments can add 1% CPR or so to the prepayment rate.

Refinancings   Prepayments on premium coupons will consist of refinancings as well as housing turnover. Typically, refinancing rates tend to accelerate when mortgage rates drop about 100bp below the WAC on the loans, and to level out when the loans are several hundred basis points in the money, as further increases in refinancing incentive lead to little marginal increase in refinancing activity. Investors should note some other points regarding refinancing:

■ Speeds on premium coupons exposed to refinancing opportunities for the first time can exceed 60% CPR. However, pools typically do not experience such high speeds for a sustained period of time. As the

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[13] See Chapter 8.

mortgagors who are the most capable or anxious to refinance exit the pool, speeds typically slow down, a process known as **burnout.**
■ However, further drops in mortgage rates may temporarily cancel the effects of burnout, as we saw in 1992, 1993, and 1998. In fact, low levels of mortgage rates seem to cause a *media effect,* with publicity about low rates and proactive mortgage lenders spurring an extra degree of refinancing activity, even in burnt-out MBSs.
■ The seasoning period for premium coupons with ample refinancing incentive is very short. In 1993, for example, MBSs less than a year seasoned prepaid at more than 50% CPR.
■ In particular, loans originated with **no points** (so that the borrowers had little up-front expense when taking out the loan) tend to have almost no seasoning period. Such loans may be refinanced even when the incentive is minimal, as the borrower just goes from one no-point loan to another, incurring little expense in the process.

How Do We Project Speeds? As this brief discussion indicates, projecting speeds is not a trivial task. Prepayment rates depend on a host of variables, such as interest rates and other economic factors; on borrower characteristics such as credit and demographics; and on mortgage characteristics such as coupon, loan age, type, previous exposure to refinancing opportunities, and so on. Recent actual speeds on a pool or a deal give some guidance, but may be misleading if interest rates have recently changed significantly.
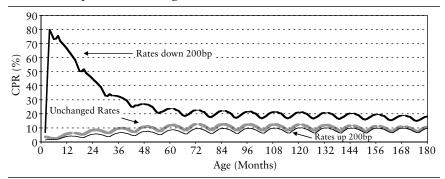
Econometric prepayment models are the usual means now to estimate likely speeds in a given interest rate environment. The Salomon Smith Barney prepayment model[14] is one such model. It uses a number of variables, such as past and current interest rates, housing inflation, mortgage characteristics, and so on, to obtain prepayment projections. Exhibit 1.11 shows projections from Salomon Smith Barney's model for new **current coupon**[15] conventional pass-throughs for several projected interest rate levels.

■ At current rates, projected speeds will be due mostly to housing turnover, and increase for several years as the loans season.

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[14] See Chapter 4. The model is available to investors through SSB's analytic system, Yield Book®.

[15] The current coupon refers to a pass-through priced at or close to par. For example, if 30-year mortgage rates are around 7%, then the typical WAC for newly issued pass-throughs will be around 7%. Assuming a servicing spread of about 50bp, this implies that 6.5% pass-throughs will be the current coupon.

EXHIBIT 1.11 Projected Monthly Prepayment Rates for a Conventional
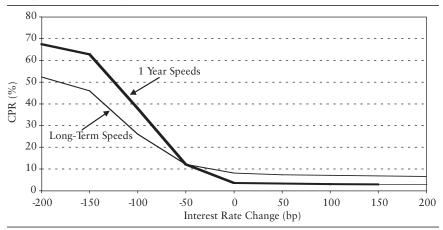Current Coupon Pass-Through

Source: Salomon Smith Barney.

■ If rates drop by 200bp, speeds rise very sharply, peaking at close to
80% CPR, and then gradually decline over time because of burnout, as
the most capable or able refinancers exit the pool.
■ If rates rise by 200bp, speeds drop, as refinancings vanish and housing
markets slow because of lower levels of affordability. The seasoning pe-
riod of the pass-through lengthens, because the mortgagors, now hold-
ing a discount loan, have a disincentive to move. However, over time,
speeds are projected to increase gradually, as housing markets adjust to
higher rate levels and the pass-through becomes fully seasoned.

For practical purposes, the vector of monthly projections from the
model is converted into a summary number, which is a weighted average of
the monthly numbers, with more weight given to earlier speeds to reflect
the higher, earlier balances.[16] Exhibit 1.12 shows one-year and long-term
(life of security) projected CPRs for the current coupon pass-through for the
three interest scenarios in Exhibit 1.12 and some additional scenarios.

The average speeds in Exhibit 1.12 reflect the same seasoning patterns
that were shown in Exhibit 1.11. In the base case and in higher interest rate
scenarios, projected speeds are lower in the short term (the next year) than in

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[16] The convention used by Salomon Smith Barney is to calculate the single speed
(either CPR or PSA) that gives the same *weighted average life* for the pass-through as
the vector of monthly projections; this is termed the *WAL-equivalent* speed.

EXHIBIT 1.12   Projected One-Year and Long-Term CPRs for a Current-Coupon Pass-Through

CPR: Constant prepayment rate.
Source: Salomon Smith Barney.

the long term. This reflects the increase in speeds over time due to turnover seasoning illustrated in the base and +200bp scenarios in Exhibit 1.11

If interest rates decline by 100bp or more, the loans become highly refinanceable, and this leads speeds to spike sharply. However, because rates are assumed to stabilize after the initial drop, *burnout* causes refinancing activity to decline over time, and thus, short-term speeds are faster than long-term ones.

Exhibit 1.11 also illustrates the distinctive S-curve that characterizes prepayment rates as a function of the economic incentive to refinance (i.e., the amount the coupon is *in the money*). Note that the S-curve is reversed in Exhibit 1.12 because the refinancing incentive increases as rates decline. For discounts (corresponding to unchanged or higher rates in Exhibit 1.11), speeds depend mostly on housing turnover, which (over longer periods of time) is relatively insensitive to interest rates; hence the S-curve is relatively flat for unchanged and higher rates. If interest rates decline, however, and the coupon becomes a premium, speeds accelerate sharply. As rates keep falling, the S-curve starts to flatten again, as the coupon is now well in the money and further increases in the refinancing incentive lead only to marginal increases in refinancing activity.

Yield, Average Life, and Spread over Treasuries

Given a prepayment projection, we can calculate an MBS's cash flows using standard formulae (see Appendix B). From the cash flows and a price, standard bond mathematics gives us the yield.

For U.S. fixed-income securities, the Treasury market is often used as a benchmark, and bond yields are typically quoted as a spread to a comparable Treasury. For MBSs, which return principal not in one lump sum (or *bullet payment*) but in uncertain monthly increments, the definition of a "comparable" Treasury is not transparent. The convention in the market is to compare MBSs to Treasuries with a maturity close to the Weighted Average Life (**WAL**) of the MBS. The WAL is defined as the average time that a dollar of principal is outstanding; it is calculated by multiplying the proportion of principal received at time *t* by *t,* and then summing over *t* (see Equation A6 in Appendix A). Exhibit 1.13 shows traditional bond analysis applied to TBA Ginnie Mae 6.5% pass-throughs.

It can be seen that both the yield and the WAL (and hence, the comparable Treasury) depend on the projected prepayment rate, which in turn depend on interest rate levels. Therefore, it is advisable to examine such measures over a range of interest rate scenarios. Exhibit 1.14 shows projected speeds, yields, and WALs for the Ginnie Mae 6.5% for parallel yield curve shifts of 100bp up and down, as well as the base case.

The results in Exhibit 1.14 illustrate both the usefulness and the shortcomings of static analysis when applied to MBSs. The analysis is useful for getting a sense of the shortening and extension of the MBS as rates change. For example, if rates drop 100bp, the Ginnie Mae 6.5% becomes a premium, prepayments surge, and the WAL shortens from 9.4 years to 3.2 years. Conversely, if rates increase 100bp, speeds slow slightly, and the WAL extends to 10.4 years. Note the asymmetry of the response, with a much

EXHIBIT 1.13 Traditional Analysis of TBA Ginnie Mae 6.5s

Price: 100-24, Assumed WAM: 29-08 Yrs., WALA: 2 months	
Projected Long-Term Speed	7.6% CPR
Yield @ Projected Speed	6.42%
WAL @ Projected Speed	9.4 Yrs.
Yield of WAL (9.4 yr) Treasury	4.90%
Spread over WAL Treasury	152bp

WAL: Weighted-average life, WALA: Weighted average loan age, WAM: Weighted-average maturity.
Source: Salomon Smith Barney.

EXHIBIT 1.14 Scenario Analysis for a Ginnie Mae 6.5% Pass-Through
(WAC: 7.00%, WAM: 29-08 Years, Price: 100–75)

	Interest Rate Moves (bp)		
	-100 bp	0 bp	100 bp
Proj. LT CPR	25.7%	7.6%	6.7%
WAL	3.2 Yrs.	9.4 Yrs.	10.4 Yrs.
Yield	6.19%	6.42%	6.44%
WAL Treasury Yield	3.78%	4.90%	5.91%
Spread/WAL Treasury	241 bp	142 bp	53 bp

Initial Yield Curve	1 Yr.	2 Yr.	3 Yr.	5 Yr.	10 Yr.	30 Yr.
	4.63 %	4.77 %	4.78 %	4.79 %	4.91 %	5.35 %

bp: Basis points, CPR: Constant prepayment rate, LT: Long term, WAC: Weighted-average
coupon, WAM: Weighted-average maturity, WAL: Weighted-average life.
Note: Interest rates are assumed to change instantaneously in parallel by the stated amount
and then remain stable.
Source: Salomon Smith Barney.

bigger change in WAL if rates drop than if rates increase. This illustrates the
fact that the Ginnie Mae 6.5%, because it is close to par and not subject to
any significant refinancings at current rate levels, is at the lower end of the
prepayment S-curve shown in Exhibit 1.12. Thus, if rates drop 100bp, the
projected speed quickly climbs up the cusp of the S-curve; however, in the
other direction, there is only a mild decline in speeds along the flat part of
the S-curve. This indication of the WAL sensitivity with respect to prepay-
ments can be especially useful for structured mortgage securities such as
CMOs (described in Part Five), because it may not be obvious otherwise for
complex structures.

However, scenario analysis has serious shortcomings for valuation
analysis. In Exhibit 1.14, the yield of the MBS declines slightly as rates drop
100bp, because the security is priced slightly above par. However, because
its WAL has shortened and the WAL Treasury has also dropped 100bp, the
spread over the WAL Treasury has increased, to 241bp. This apparently
strong performance versus Treasuries is misleading, of course; the high pre-
payments on the MBS have to be reinvested at lower prevailing rates. In ad-
dition, receiving principal back at par is a negative for the investor, because
the MBS was priced above par. This problem would be more serious for a
higher coupon priced well above par.

We describe a sounder methodology to estimate the impact of interest
rate and prepayment variations in the next section.

1.4 OPTION-ADJUSTED ANALYSIS OF MORTGAGE SECURITIES

> *. . .The race is not to the swift, nor the battle to the strong, neither yet bread to the wise, nor yet riches to men of understanding, nor yet favor to men of skill; but time and chance happeneth to them all.*
>
> Ecclesiastes 9:11

Traditional bond analysis has serious limitations when applied to MBSs (or indeed any other type of callable bond). Among these limitations are:

- The **yield spread,** the standard measure of incremental return over a benchmark Treasury, compares an MBS to a single, somewhat arbitrarily chosen point on the yield curve. Because an MBS returns principal over a period of time, rather than in one lump sum, it would be preferable to compare it to an appropriate portfolio of Treasuries.
- MBS cash flows vary with interest rates, typically in a manner adverse to the MBS holder. The cost of such prepayment variation needs to be incorporated in any measure of the MBS's return relative to Treasuries.

In the mid-1980s, Salomon Brothers pioneered the development of option-adjusted analysis for MBSs.[17] This approach has since become widely used to analyze MBSs and other callable bonds. Here we give a brief description of the methodology and its application to MBSs.

Yield Curve Spread

Developing a more accurate static measure of incremental return over Treasuries—improving on the yield spread—is straightforward. Let us go back to the Ginnie Mae 6.5% example illustrated in Exhibits 1.13 and 1.14. In the base case, given the projected speed, the yield of the Ginnie Mae 6.5% was 6.43%, its WAL was 9.4 years, the interpolated 9.4-year Treasury yield was 4.90%, and hence, the Ginnie Mae 6.5's spread to its WAL Treasury was 142bp.

This analysis can be interpreted as assuming that the Ginnie Mae 6.5% returns all its principal after 9.4 years (i.e., it is a 9.4-year bullet security), and thus, the appropriate discount rate is the 9.4-year Treasury plus a spread (in this case, 142bp). Rather than making this assumption, we can

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[17] See *Evaluating the Option Features of Mortgage Securities: The Salomon Brothers Mortgage Pricing Model,* Salomon Brothers Inc., 1986.

discount each cash flow from the Ginnie Mae 6.5% by an appropriate Treasury rate plus a spread. For example, the cash flow in month 64 can be discounted by the 64-month Treasury zero rate plus a spread. Instead of zero rates, we could use forward rates. If $f_1, f_2, \ldots$ are the one-month forward rates (based on the current yield curve) for months 1, 2, . . ., then for a given spread s the discount rate for month n is

$$\mathrm{DIS}(n, s) = \frac{1}{[(1+f_1+s)(1+f_2+s)\ldots(1+f_n+s)]} \tag{1.1}$$

Hence, if CF(1), CF(2), . . . are the projected cash flows from the Ginnie Mae 6.5%, then their present value is

$$\mathrm{PV}(s) = \mathrm{C}(1) \times \mathrm{DIS}(1, s) + \mathrm{CF}(2) \times \mathrm{DIS}(2, s) + \ldots \tag{1.2}$$

The value of s that makes the present value PV(s) equal to the market price is the solution of

$$\mathrm{Price} = \mathrm{PV}(s) \tag{1.3}$$

and is defined as the **yield curve spread** (**YCS**).[18] In concept, it is similar to the standard spread over Treasuries, but it is clearly a more accurate measure of incremental return over Treasuries for securities that return principal not in one lump sum but over many periods. Rather than calculating the incremental return over a single Treasury, the YCS gives it relative to a portfolio of Treasuries chosen according to the timing of the MBS's cash flows.

For a flattish yield curve, the YCS and the spread/WAL will tend to be very close to each other. In general, the relationship between the YCS and the spread/WAL will depend on the shape of the yield curve and the dispersion of the MBS's cash flows. For the current mildly upward sloping yield curve, intermediate and longer forward rates are much higher than spot rates; hence, the YCS is lower than the spread/WAL for longer MBSs, such as discount pass-throughs, while it is about the same or slightly higher than the spread/WAL for shorter-average-life securities.

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[18] Other names for the yield curve spread include yield curve margin and zero-volatility OAS.

Option-Adjusted Spread

The yield curve spread, while an improvement over the standard yield spread, is still a static measure; that is, it assumes that interest rates and cash flows remain unchanged. Of course, such an assumption is at variance with reality. Interest rates and prepayment speeds will vary over time in an uncertain manner.

In general, the MBS investor suffers a cost as a result of this variation. We can think of this cost as the value of the embedded option in the MBS resulting from the mortgagors' ability to prepay their loans at any time. However, it is a complicated effect, with several factors at work, and standard option pricing theory can be of limited use:

■ The strongest factor is typically **reinvestment risk.** Prepayment speeds tend to increase when interest rates decline, so that the investor has to reinvest an increased amount of prepaid principal at lower prevailing rates. Conversely, if interest rates increase, prepayments will decline, reducing the cash flow that the investor can reinvest at prevailing higher rates.

■ Changes in prepayments change the time until each dollar of principal is returned. Thus, for example, for MBSs priced at a deep discount, if there is a decline in interest rates and a corresponding pickup in speeds, the benefit of earlier return of principal at par may mitigate or even outweigh reinvestment risk. An example is provided by POs, which typically benefit from interest rate and prepayment volatility.

■ The impact of typical prepayment patterns is often quite different from that implied by option valuation theory. For example, if speeds on a high premium security have reached an upper plateau, volatility can be a benefit, because speeds cannot increase much but can decline significantly; very high coupon IOs can provide an example. In addition, note that no matter how out of the money mortgage loans are, there will always be some prepayments, because of home sales.

How do we incorporate interest rate (and hence, prepayment) volatility in the valuation of MBSs? For a *given* path of interest rates and a *given* spread *s,* the projected value of the MBS is given by Equation 1.2. Financial theory tells us that the value of a stream of contingent cash flows is (under certain conditions) the expected present value of the cash flow stream. Hence, with PV(*s*) defined as in Equation 1.2,

$$
\text{Value of MBS} = \begin{array}{l} \text{Average value of PV}(s) \text{ over} \\ \text{all possible interest rate paths} \end{array} \tag{1.4}
$$

$$
= \text{AVGPV}(s)
$$

The option-adjusted spread (OAS) is defined as the value of *s* in Equation 2.4 that makes the value of the MBS equal to its market price; that is, it is the solution of

$$\text{Price} = \text{AVGPV}(s) \tag{1.5}$$

Thus, conceptually, the OAS is a straightforward extension of the traditional yield spread over Treasuries. We start by replacing a single Treasury discount rate by a series of forward rates to determine the YCS and then factor in the effect of volatility by calculating this spread over the spectrum of possible future interest rates. However, the actual calculation of the OAS involves some complicated steps, as we discuss next.

Interest Rate Volatility and Calculation of OAS

To calculate the expected value over future interest rate paths, a **term structure model** is needed to describe the evolution of interest rates over time.[19] Such a model must be consistent with today's yield curve (this typically means that the set of benchmark Treasuries must be fairly priced under the model—they must have zero OASs), and it should generate interest rate paths that are internally consistent (that do not lead to arbitrage opportunities) as well as consistent with historical interest rate behavior.

A **one-factor** model has just one random factor that shocks the yield curve each period; hence, such a model assumes that different interest rates are perfectly correlated. A **two-factor** term structure model, such as the Salomon Smith Barney model, avoids this unrealistic assumption and is preferable, leading to more realistic simulated interest rate paths. In addition, Salomon Smith Barney's model includes another desirable characteristic of term structure models, namely **mean reversion.** This property prevents simulated rate paths from going to levels, such as more than 100%, that seem unlikely for a stable country such as the United States.[20]

Volatility   An important element in the term structure model is the specification of volatilities. A good model should give different volatilities for different maturity rates. For example, three-month Treasury yields tend to be more volatile than 10-year Treasury yields, and the interest rate paths generated by the term structure model should reflect this. A term structure

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[19] More precisely, the model describes the evolution of the term structure of interest rates, hence, the name given to such models.

[20] For a more detailed description of Salomon Smith Barney's two-factor term structure model, see Chapter 13.

model that has different volatilities for different maturity interest rates is said to incorporate a **term structure of volatility.**

Two different sources of volatility inputs are, (1) empirical volatilities calculated from historical interest rates, and (2) the options markets. In the first case, the parameters within the term structure model are adjusted so that simulated interest rate paths display specified volatilities. The second method uses implied volatilities from the options markets. In this case, the model parameters are chosen so that the model reprices a chosen set of option instruments. Both methods provide useful insight into MBS value.

Calculation of OAS   Simulation is used to evaluate the expected value in Equation 1.5. The steps are as follows:

1. Using computer generated pseudorandom numbers and the term structure model, hundreds of hypothetical interest rate paths are simulated, including short-term rates for discounting and longer term rates that are important for prepayment analysis.
2. On each interest rate path the prepayment model is used to project prepayment rates and, hence, the MBS's cash flows.
3. For each path, the present value of the cash flows is calculated using Equation 1.2, with the discount rates being the short-term forward rates along that path plus a specified spread s. The average of these present values gives us an estimate for the AVGPV(s) term in Equation 1.4.

To find the OAS corresponding to a given market price, we start with an initial estimate for the OAS and use iteration to solve Equation 1.5. That is, we start with an initial spread s, calculate AVGPV(s), and keep adjusting s until AVGPV(s) equals the market price (within a given tolerance). Conversely, we can use Equation 1.5 to find the theoretical price corresponding to a given OAS.

Option Costs and Interpretation of OAS

Exhibit 1.15 shows a portion of a daily Salomon Smith Barney report,[21] illustrating a typical example of OAS analysis.

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[21] For readers who have access to the Yield Book® and SSB Direct, the report is on the manifold system as MB713.

EXHIBIT 1.15 OASs for Ginnie Mae Pass-Throughs

Coupon	WAM	Price	Proj. LT CPR	Yield	WAL	Spread/ WAL	YCS	OAS	Option Cost
6.0%	29-10	98-17	5.3%	6.24%	11.4 Yrs	130 bp	110 bp	70 bp	40 bp
6.5	29-08	100-23	7.5	6.42	9.5	153	134	75	59
7.0	28-04	102-10	12.6	6.51	6.5	166	153	78	75
7.5	28-02	103-10	20.3	6.42	4.2	160	161	85	76
8.0	28-01	104-10	23.4	6.41	3.6	160	167	105	62
8.5	28-00	106-02	23.3	6.33	3.7	152	158	108	50

bp: Basis points, CPR: Constant prepayment rate, LT: Long term, OAS: Option-adjusted spread, WAL: Weighted-average life, YCS: Yield curve spread.
Note: Prices and Treasury rates as of the close of February 11, 1999, using market volatilities.
Source: Salomon Smith Barney.

The option cost is the difference between the zero volatility OAS (the YCS) and the OAS. It is a measure of the cost to the investor of volatility in interest rates and, hence, in prepayments. Thus, for the Ginnie Mae 6%, the YCS is 110bp, the OAS is 70bp, and, hence, the option cost is 40bp. The Ginnie Mae 6% is a discount. Thus, it has some degree of call protection (the option is out of the money), and the option cost is lower than for higher coupons. For the Ginnie Mae 7.5%, in comparison, the option cost is much higher, at 76bp; the Ginnie Mae 7.5% is a premium and on the "cuspy" part of the prepayment curve. Therefore, small interest rate changes can lead to sharp prepayment speed changes.

As shown in Exhibit 1.1, as the coupon increases, the option cost eventually starts to decline, even though, theoretically, the coupons are becoming deeper and deeper in the money. This illustrates the complex and multidimensional nature of prepayment behavior. The critical element is not the amount that the coupon is in the money, but the sensitivity of speeds to interest rate changes (or the slope of the prepayment curve). Recall that prepayment speeds, as a function of the coupon, resemble an "S" curve—they tend to be flat for discount coupons, increase sharply as the coupon becomes a premium, and then level out at very high premiums. Therefore, speeds on high premiums, like those on discounts, tend to be less affected by small interest rate changes than speeds on cuspy coupons.

What Does the OAS Represent and How Should It Be Used?   In the relatively short time since its development, OAS analysis has become an essential tool for MBS investors. Its widespread acceptance indicates that most investors are well aware of the optionality inherent in MBSs. However, while OASs are a critical component in analyzing MBSs, investors should be aware of their limitations and of the many assumptions that go into an OAS calculation.

The OAS has been derived here as an extension of the standard spread over Treasuries, to account for the dispersion and uncertainty associated with the return of principal from MBSs. Can it be realized as a return over Treasuries? Theoretically, with dynamic hedging, the answer is yes, *provided all the assumptions in the model (for term structure movements, prepayments, volatility, etc.) hold true.*[22]

From a practical point of view, it is perhaps best to think of the OAS playing the same role for MBSs (and other callable bonds) as the standard spread does for noncallable bullet bonds; that is, it acts as a useful measure of relative value, allowing an assessment of an MBS's value relative both to other MBSs and to its own past levels. In fact, various studies have shown that, applied consistently over time, OASs can be good indicators of cheap or rich MBSs.[23] However, while the OAS can act as an initial filter in identifying seemingly rich or cheap securities, it is a single, summary number and investors should supplement it with other analyses such as holding-period returns to obtain a more complete risk/reward profile of the security.

Assumptions in OAS Models   Although widely used, market participants maintain some skepticism about OASs. Much of this skepticism derives from the often wide differences in OASs produced for the same securities by different firms' models. However, given the steps involved in the OAS calculation, it would be surprising if such disparities did *not* occur. Recall that the two main steps are:

1. Generating a set of interest rate paths.
2. Projecting prepayment rates along each such path.

The first step involves using a term structure model and making a set of volatility assumptions. No consensus exists as to the correct term structure or volatility model, and thus, it is natural that models differ. Similarly, it goes without saying that prepayment projections, which involve assumptions about future demographic trends, housing markets, and economic conditions, will differ from model to model.

Given that it is inevitable that different models will produce different numbers, investors should become comfortable with one or two well-formulated and consistent models—in particular, understanding key assumptions—and use these models.

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[22] This is discussed in more detail in Chapter 13.
[23] For example, see *Using OAS to Enhance Mortgage Portfolio Returns,* Salomon Brothers Inc., April 1989.

Effective Duration

Standard duration measures, such as Macaulay or modified, can be misleading for MBSs, because of the dependence of MBS cash flows on interest rates. OAS methods provide a more useful measure, generally known as *effective duration.*

The standard formula to calculate effective duration is given by Equation A9 in Appendix A. Effective duration is defined as the percentage price change for a 100-basis point parallel change in yields, assuming the OAS remains unchanged. The calculation is illustrated in Exhibit 1.16 for a Ginnie Mae 7.5%.

As interest rates change, the usual impact of changing discount rates on fixed-income securities tends to be reduced in the case of mortgage securities by changes in prepayments. This effect is most pronounced for cuspy premiums. As interest rates decline, the positive effect of lower discount rates is partly balanced by the negative effect of higher prepayment speeds, resulting in a smaller price increase. Conversely, if rates rise, declines in speeds can mitigate the discount-rate-related price decline. The net effect is that the effective duration is lower than the modified duration for prepayment-sensitive securities. In the case of the Ginnie Mae 7.5% shown in Exhibit 1.16, the modified duration is about 3 years, compared with the effective duration of 1.8 years. IOs represent an extreme case for which the effect of prepayment changes overwhelm the discount rate effect, leading to negative durations. However, deep discounts and seasoned high premiums may have similar effective and modified durations, because speeds on these coupons change little for a small change in interest rates.

EXHIBIT 1.16 Calculation of Effective Duration for a Ginnie Mae 7.5% Pass-Through

1) Current price = 103-10 $\longrightarrow$ OAS = 85bp

2) Interest rates move down 50bp in parallel: OAS = 85bp $\longrightarrow$ Price = 103.93

3) Interest rates move up 50bp in parallel: OAS = 85bp $\longrightarrow$ Price = 102.08

4) Effective Duration = pct. price change per 100bp change in yields

$$= 100 \times (103.93 - 102.08) / 103.31$$

$$\cong 1.8$$

bp: Basis points, OAS: Option-adjusted spread.
Note: Based on closing prices and market volumes as of February 11, 1999.
Source: Salomon Smith Barney Inc.

Effective Durations and Market Price Moves Market price moves for MBSs often differ from those predicted by effective durations, even for good OAS models. This should not be surprising, given the assumptions used in calculating effective durations. Major assumptions include:

- Constant OAS
- Parallel yield curve shifts
- No change in other relevant factors, such as mortgage rate to Treasury spreads and volatilities
- Symmetric price changes

These assumptions rarely hold in practice, leading to deviations between effective and empirical durations.[24] Furthermore, interest rate changes can lead to substantial shifts in a particular MBS's effective duration. For example, the effective duration of a conventional 6.5%, the current coupon at the time of writing, is projected to drop from about four to about one if interest rates decline by 100bp (other things being equal). However, over a longer period of time, as deviations from assumptions average out, effective durations from a good OAS model should track empirical durations.[25]
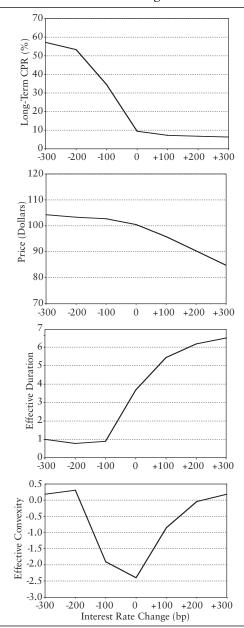
Convexity

As with duration, OAS methodology leads to more meaningful convexity estimates for MBSs than traditional measures. The formula used to calculate convexity for MBSs is given by Equation A10 in Appendix A. As with the effective duration calculation, price changes are calculated assuming parallel yield curve shifts and a constant OAS, with the convexity calculated by comparing the relative price change in up-rate moves with that in down-rate moves.

Noncallable bonds have positive convexity; that is, the percentage price increase if interest rates decline is greater than the percentage price decline if rates increase by the same (small) amount. In other words, if the price is plotted against various interest rates, the curve will be convex. For MBSs, convexity is often negative, because rising prepayment rates dampen the price increase in declining rate scenarios. Exhibit 1.17 plots projected prices, effective durations and convexities for a conventional 6.5% for various interest rate levels.

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[24] Empirical durations refer to those calculated from market price changes.

[25] A detailed discussion of this topic is given in Chapter 14.

EXHIBIT 1.17 Conventional 6.5s—Projected Speeds, Prices, Durations, and Convexities for Various Interest Rate Changes

As interest rates drop, prepayments on the conventional 6.5s accelerate, leading to a slowdown in price appreciation, which is reflected as a decline in duration. This decline in turn is reflected in the negative convexity of the bond. As rates keep dropping and projected speeds on the 6.5s level off, the duration and the convexity start to increase. In fact, for a 200bp drop, the convexity becomes positive; the 6.5% is a high premium, speeds have leveled off, and it assumes some of the characteristics of a short fixed-cash-flow bond.

If interest rates increase, prepayments on the 6.5% slow down and become less sensitive to rate change. As a result, the duration and convexity both increase, with the convexity again eventually becoming positive.
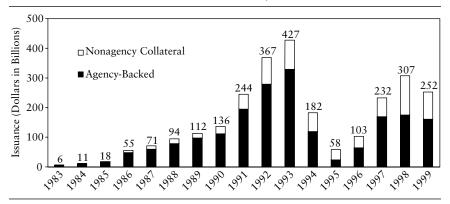
What Does Negative Convexity Mean for Investors?   Convexity is a method to estimate the impact of prepayment variation on the likely price appreciation of an MBS. For an MBS, negative convexity dampens the price appreciation if interest rates fall. Thus, even though the MBS may have significantly higher returns than a comparable Treasury under unchanged rates, it may underperform the Treasury if rates drop.

However, subject to the assumptions in the model, the OAS incorporates the impact of prepayment volatility and, hence, of negative convexity. Does this mean that two bonds with the same OAS should be treated the same, even if one has much more negative convexity than the other? To some extent, yes, because presumably the MBS with the greater negative convexity had a higher nominal yield, in order to arrive at the same OAS. However, to the extent that reality deviates from the assumptions in the OAS model and given that it is difficult to dynamically hedge the MBS so as to fully realize the OAS, higher negative convexity does imply a greater degree of uncertainty about the OAS. This observation reinforces the point made earlier, that investors should supplement OAS with scenario and holding period analysis to obtain a more complete risk/reward profile for the MBS, as well as stress-testing the results by changing some of the assumptions (e.g., refinancing sensitivity) in the model.

1.5 STRUCTURED MORTGAGE-BACKED SECURITIES

Despite the dramatic growth of the mortgage pass-through market, the cash-flow characteristics of pass-throughs did not meet the needs of some institutional investors. To broaden the range of potential investors, structured mortgage-backed instruments with a variety of maturity and prepayment profiles have been created out of basic mortgage cash flows.

EXHIBIT 1.18 CMO Issuance, 1983–1999

Source: Inside Mortgage Finance Publications, Salomon Smith Barney.
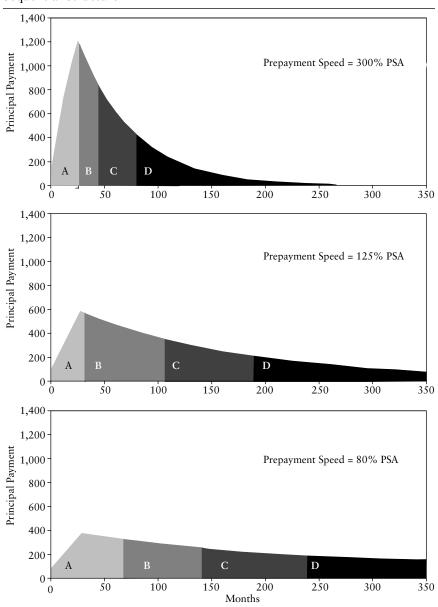
A landmark in the development of the MBS market occurred in June 1983, when Freddie Mac issued the first CMO. Since then, the CMO market has grown rapidly, and as of year-end 1998, more than $2.3 trillion of CMOs have been brought to market by Freddie Mac and Fannie Mae, investment banks, mortgage bankers, thrifts, home builders, insurance companies, and commercial banks (see Exhibit 1.18). In recent years, the majority of CMOs have been issued under the Fannie Mae and Freddie Mac name.[26]

Development of the CMO Market

CMOs comprise a number of classes of bonds issued against specified mortgage collateral. The collateral can be agency pass-through pools, whole loans (typically, nonconforming loans), or classes from other CMO deals (termed Re-REMICs). Early CMO structures, which typically had three or four classes, illustrate well the basic CMO principle. Exhibit 1.19 shows a hypothetical CMO with four classes labeled A, B, C, and D. These classes, or *tranches,* are retired sequentially. All principal payments are directed first to the bonds with the shortest maturity, the class A bonds. When the A bonds are retired, the principal payments are directed to the bonds with the next shortest maturity, the class B bonds. The process

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[26] The term real estate mortgage investment conduit (REMIC) is often used synonymously with CMOs. The Tax Reform Act of 1986 allowed CMOs to be issued in the form of REMICs, which have certain tax and accounting advantages for the issuer. Most CMOs are issued now as REMICs.

EXHIBIT 1.19 Principal Payments to CMO Bonds with a Four-Class Sequential Structure

Source: Salomon Smith Barney.

continues until all of the bond classes have been paid off. The allocation of cash flows from a pool of mortgages among the classes of this type of CMO is illustrated in Exhibit 1.19 at several different prepayment rates.

The CMO structure shown in Exhibit 1.19 creates short-, intermediate-, and long-term MBSs from the underlying collateral, giving investors a choice of maturities. Class A remains a relatively short-term security even if prepayment speeds slow down, while the later classes obtain a degree of call protection because the earlier classes act as a buffer against prepayments.

In addition to more choice in maturity characteristics, several other factors played a role in the expansion of the CMO market:

■ The size of typical CMO deals means that monthly speeds are less erratic than for a typical pass-through pool. CMO deals are typically collateralized by several hundred pools, which leads to geographical diversification in the underlying loans as well as a reduction in the degree of "noise" in monthly prepayments.
■ Agency CMOs offer the same high credit quality as corresponding agency pass-throughs.
■ CMO classes often offer attractive yields relative to other comparable credit quality fixed-income instruments.

Another major factor in the expansion of the CMO market is the development of numerous CMO bond types, catering to different investor needs—in essence, customizing mortgage cash flows.

CMO Bond Types

The classes in the hypothetical CMO deal shown in Exhibit 1.19 is usually labeled **sequential** bonds, for the obvious reason that principal is allocated sequentially to the classes. A detailed description of the structure of MBS is given in Chapter 15, and a glossary of standard agency definitions of the many different bond types developed over the years is given in Appendix B. Here, we provide a brief description of the main types.

Accrual or Z-Bonds   The Z-bond was the first departure from standard sequential bonds. As the name implies, Z-bonds receive no interest until their principal payment window starts. Instead, the interest due is accrued and added to the Z-bond's principal balance, which, as a result, increases until earlier classes are retired, and collateral cash flows are directed toward making interest and principal payments to the Z-bond. The Z-bond was typically the last bond in a CMO deal, although in recent years many deals placed Z-bonds earlier in the structure.

A Z-bond has a beneficial effect on the cash flow stability of earlier bonds, because the interest that should have been paid to the Z-bond is used to pay down the other bonds. Hence, if prepayment speeds slow, the growing balance on the Z-bond and the increasing amount of Z-bond interest available for paying down the other bonds can partially balance the effect of slower collateral principal payments.
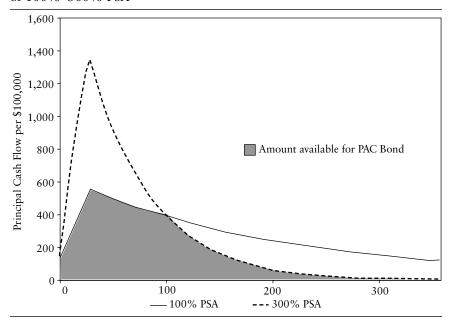
PACs, TACs, and Companions   Planned amortization class (PAC) bonds are perhaps the most important innovation in the CMO market to date. First issued in 1986, PAC bonds and their various offshoots have dominated CMO issuance since early 1989. Because of their central role in the CMO market, PACs will be discussed in somewhat more detail here than other CMO bond types.

PACs expand on the basic rationale behind CMO bonds. Whereas the early CMO bonds used sequential segmentation of principal to offer investors a better defined maturity profile than pass-throughs, PAC bonds go further and essentially remove maturity uncertainty *provided prepayments stay within a given range.* A PAC bond is characterized by a specified principal payment schedule (much like a sinking fund on a corporate bond). In allocating principal paydowns from the collateral to the CMO bonds, priority is given to meeting the PAC principal schedule; thus, other bonds in the deal, termed **support** or **companion** bonds, for obvious reasons, absorb prepayment variations as much as possible. As might be expected, companion bonds typically have a high degree of WAL sensitivity to prepayment changes and tend to be priced at higher yields as compensation.

A PAC bond's degree of prepayment protection is typically characterized by a **PAC band,** such as 100% to 300% PSA. The PAC's principal payment schedule is derived by taking the minimum of the collateral principal payments at two constant speeds (in this example 100% PSA and 300% PSA), as shown Exhibit 1.20; these two speeds will constitute the PAC band. The shaded area in Exhibit 1.20 represents the maximum available principal paydown schedule for the specified PAC band. The PAC's payment schedule will be met as long as the collateral prepays at a *constant* prepayment rate that is within the stated PAC band. The schedule may not be met if speeds vary over time, even if they stay within the PAC band.

Offshoots of PAC bonds include **Targeted Amortization Class (TAC)** bonds, **reverse TACs, PAC Is, PAC IIs,** and so on. TAC bonds are in essence one-sided PACs; they provide a degree of call protection if prepayment speeds increase from pricing assumptions. Reverse TACs, as the name implies, provide protection against a slowdown in speeds. PAC Is, PAC IIs, and so on are PAC bonds with progressively narrower PAC bands than standard PAC bonds.

EXHIBIT 1.20 Creating a PAC Principal Payment Schedule with a PAC Band of 100%–300% PSA

PAC: Planned amortization class.
Source: Salomon Smith Barney.

A more detailed analysis of PAC structures is given elsewhere.[27] Some general rules should be kept in mind:

- PAC bonds typically have more call risk than extension risk. The lower PAC band—typically 80% to 100% PSA for conventional collateral and lower for Ginnie Maes—is unlikely to be broken to any appreciable degree, because normal housing turnover implies that average speeds are unlikely to fall below the lower PAC band for any length of time. However, if interest rates drop, speeds may well exceed the upper band (typically in the 250%–400% PSA), especially for coupons exposed to refinancing opportunities for the first time.

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[27] For example, see "Anatomy of PAC Bonds," Michael Bykhovsky and Lakhbir Hayre, *Journal of Fixed Income,* June 1992, and Chapter 15.

- As prepayments vary from the pricing speed and support bonds are paid down at rates different from initial pricing assumptions, the effective PAC bands will change, a phenomenon known as *PAC band drift.* This drift is typically small and gradual, with the lower and the upper bands rising. However, the effect does emphasize that it is essential to evaluate PAC (and other CMO) bonds using a vector of monthly projections rather than a single (or scalar) projected CPR or PSA.
- In most cases, short-term PACs (WALs less than two to three years) have low prepayment uncertainty. Even if prepayment speeds pick up significantly, the companion classes will still be there to absorb the extra principal payments.

It is difficult to make general statements about PACs (or other CMO bonds). Much depends on the collateral and its prepayment profile as interest rates change. Also important is the structure of the CMO—-for example, the amount of support classes remaining in the deal. Although CMO bonds are typically priced at a spread over a benchmark Treasury, OAS analysis is critical in evaluating the effect of changing interest rates and prepayments on a particular CMO structure.[28]

Floating-Rate Bonds   Floating CMO bonds were first issued in September 1986. The coupons typically reset monthly at a stated spread over an index (LIBOR being the most common) subject to a cap on the coupon. Floating-rate CMOs appeal to many European and Japanese investors, as well as U.S. commercial banks and thrifts.

The cap on floating CMO bonds is typically higher than the coupon on the fixed-rate collateral, because a low cap would diminish the floater's appeal to investors. In structuring such bonds, it is necessary to ensure that the coupon income from the collateral is sufficient to make the coupon payments on the floaters for any combination of the index and prepayment rates.

The usual solution is to pair the floater with an **inverse floater,** which pays down simultaneously with the floater. As suggested by the name, the coupon on the inverse floater moves inversely with the index, such that the combination of the floater and the inverse floater is a fixed-rate bond with a coupon equal to or less than the collateral coupon. This constraint still

[28] Also useful is a technique called **distribution analysis,** which involves examining WALs and other bond characteristics over the hundreds of paths used to calculate OASs, for example, examining the WAL stability of a PAC bond over varied and realistic interest rate paths. A description of distributional analysis is given in "Anatomy of PAC Bonds." SSB's Yield Book®, allows distributional analysis for CMOs.

allows a fair degree of flexibility in the structuring of the bonds. For example, if we issue $80 million of the floater and $20 million of the inverse, it is not difficult to see that for every basis point increase in the index (and, hence, in the floater coupon), the coupon on the inverse has to decline by a factor of 80/20, or four. This number is termed the **multiplier** or **leverage** of the inverse floater coupon. Alternatively, we could issue $66.67 million of the floater and $33.33 million of the inverse floaters, in which case the inverse floater would have a multiplier of two.[29] Floaters can be structured, in terms of principal paydown types, as sequential-pay bonds, PACs, TACs, companions, and so on.

Conceptually, CMO floaters are straightforward extensions of standard floating-rate bonds, with prepayment variability adding a new dimension. OAS methodology provides a means of estimating the net combined effect of the cap and of prepayment variations. Typically, CMO floaters offer cap- and prepayment-adjusted returns superior to those of similar credit quality standard floaters.

Inverse floaters are an unusual type of instrument. Properly used, they provide a unique means of reducing the interest rate exposure of a fixed-income portfolio, and they have the potential to provide very high returns. However, inverse floaters are exposed to a variety of interest-rate and prepayment risks and are recommended only for investors possessing the background and analytic tools to understand these risks.

Stripped Mortgage-Backed Securities

First issued in 1986, mortgage STRIPs are created by dividing the cash flows from a pool of mortgages or mortgage securities and allocating specified percentages of interest and principal to each new STRIP. For example, a Fannie Mae 9% pass-through can be stripped to produce two securities, one with a 6% coupon and the other with a 12% coupon, simply by directing more of the interest from the underlying collateral to the higher coupon and less of the interest to the lower coupon.[30] If the ratio of interest to principal is varied, STRIPs with a wide range of coupons and performance characteristics can be created.

The predominant types of mortgage STRIPs (constituting almost all the issuance in recent years), and the most elementary, are IO and PO STRIPs.

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[29] The coupons have to be modified for caps and the inverse floater coupon has a floor.

[30] For example, if each security receives 50% of the principal, then by directing one-third of the interest to the first security and the remaining two-thirds to the second security, we create 6% and 12% coupons.

IO STRIPs receive all of the interest payments from the underlying collateral and none of the principal. PO STRIPs receive all of the principal and none of the interest.
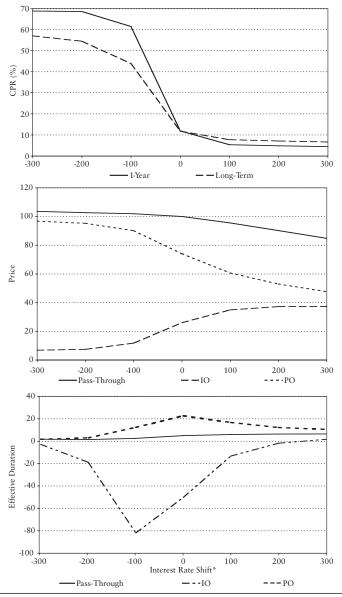
IOs and POs are much more sensitive to prepayment rate changes than the underlying collateral. Faster prepayments reduce the principal balance of the underlying collateral more rapidly, leading to smaller interest payments in future periods and hurting the IO, but returning principal at par at a faster rate, helping the PO. Conversely, slower prepayments help IOs but hurt POs.

Exhibit 1.21 shows projected speeds, prices, and effective durations under changing interest rates for hypothetical IOs and POs and for the underlying current coupon pass-through collateral. The graph illustrates the complex combined effects of changing discount and prepayment rates on IOs and POs.

■ As interest rates decline, speeds on the collateral begin to accelerate. For the PO, higher speeds combined with lower discount rates boost the price, leading to a high positive duration and also giving the PO positive convexity. For the IO, the price actually falls as interest rates decline, as higher speeds overwhelm the effect of lower discount rates; hence, the IO displays negative duration.
■ As interest rates continue to drop and prepayments begin to level off, the rate of price appreciation for the PO begins to slow, while for the IO the price begins to level off. Fairly stable speeds means that the discount rate effect becomes relatively more important. Thus, the duration of the PO starts to decline, while that of the IO begins to increase.
■ Increasing interest rates lead to slower prepayments, which hurt the PO and help the IO. The IO price increases as slower prepayments outweigh higher discount rates. Again, however, as interest rates keep increasing and speeds level off at the lower end of the prepayment S-curve, the effect of lower discount rates begins to dominate, and the IO price levels off and eventually declines as rates continue to increase, thus displaying positive duration.[31]

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[31] The analysis in Exhibit 1.21 was done at a time when interest rates were at historically low levels, with the 10-year Treasury yield at 5%. Hence, the declining rate scenarios in Exhibit 1.21(with a drop of 200bp corresponding to a 10-year rate of 3%) take interest rates to levels not seen in recent decades and may correspond to a severe recession. In this case, the projected prepayment speeds for these scenarios may be too fast.

EXHIBIT 1.21 Projected Speeds, Prices, and Durations for Hypothetical Current-Coupon IOs and POs

*Parallel shift in basis points.
CPR:Constant prepayment rate, IO: Interest only, PO: Principal only.
Source: Salomon Smith Barney.

The IO and PO market acts as a barometer of market perceptions and expectations of prepayment speeds, and the unusual duration characteristics of these instruments make them among the most versatile and useful vehicles in the fixed-income markets. Investors can use IOs and POs to hedge prepayment or interest rate risk or combine them with other securities to create synthetic instruments or portfolios with desired investment or duration profiles. They also can be used simply to take a position on prepayments. However, their extreme sensitivity to prepayments implies a high degree of risk, and investors in these instruments should have a correspondingly high degree of understanding of prepayment and OAS analysis.

1.6 THE NON-AGENCY MARKET

In this section we give an overview of non-agency (or nonconforming) mortgage securities, including commercial MBSs (CMBSs). This is a large and diverse sector, covering the complete spectrum of borrower demographics and credit characteristics, as well as loan sizes and types.

Cash Flow Structure of Non-Agency Mortgage Securities

Despite the many different types of collateral backing non-agency deals, the cash flow structures of these deals tend to be fairly similar. With agency MBSs, agency guarantees assure investors that they will receive timely payment of interest and principal, regardless of the delinquency or default rates on the underlying loans. Because non-agency MBSs have no such guarantees, some other form of protection (or credit enhancement) is needed to protect investors from borrower delinquencies. Most deals now have *internal credit enhancement* through a senior/subordinated structure.[32] In its most basic form, there is a *senior* class and a *subordinated* (or *junior*) class; the latter absorbs principal shortfalls from liquidation (hence, it is sometimes called a first-loss piece). Rating agency requirements determine the amount of the subordinated class, but typically, for the senior class to be rated AAA, 4% to 20% of the deal, depending on the collateral, tends to be in the junior classes. The AAA class is then typically structured as a CMO,

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[32] *External Credit Enhancement,* infrequently used in recent years, means obtaining insurance of some sort from an external source to cover shortfalls and losses resulting from delinquencies and defaults.

EXHIBIT 1.22   Typical Structure for a Non-Agency Deal

Source: Salomon Smith Barney.

with PACs, sequential bonds, and so on. The junior class itself is often tranched, but along credit lines, from AA or A (sometimes called *mezzanine* classes) down to an unrated piece. As the ratings imply, any principal losses are absorbed in reverse order (i.e., the unrated class is the first-loss piece). Exhibit 1.22 shows a typical structure for a non-agency MBS deal.

Non-agency MBSs, particularly those with lower ratings, tend to trade at much wider spreads than comparable corporate bonds. For example, recent spreads on BBB-rated non-agency MBSs have been close to 300bp, or more than 150bp higher than BBB-rated corporates.[33] We could, in fact, argue that the law of large numbers implies less uncertainty about credit losses for a large geographically diversified group of mortgage loans than for a single corporation, in which the investor has greater exposure to event risk. This implies that, for example, a BBB-rated bond from a deal backed by such a group of loans should trade *tighter,* not wider than a BBB-rated corporate bond.

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[33] Although the subordinated MBS classes have some prepayment risk, it tends to be relatively minor, because prepayments are directed to the senior classes, and in fact, the junior classes typically have prepayment lock-outs for a number of years.

Types of Nonconforming Residential Mortgages

Exhibit 1.23 gives a rough schematic representation of some of the main sectors of the nonconforming market.[34] Also shown are some major issuers in the various sectors.

Traditional Jumbo Loans   Deals backed by such loans (generally termed whole loan [WL] deals) constitute the largest sector of the non-agency market, with issuance in 1998 of about $105 billion, and a total outstanding market size of $265 billion. As might be expected, such loans are characterized by the following:

- Affluent, financially sophisticated borrowers.
- Large loan sizes, with a current average of around $325,000, compared to an average of about $120,000 for agency loans.
- A heavy California (and to a lesser extent, Northeast) concentration, with most deals having 30% to 50% of the loans from California.
- Generally high credits, and LTV ratios below 80%.

These factors imply:

- Very efficient refinancers and, hence, fast speeds in an interest rate rally;
- Strong geographical effects—for example, speeds on WL deals were generally slower than on comparable agency pools from 1994 to 1997 because of the California housing recession of the time;
- Generally low default rates, although, again, geographical effects could outweigh demographic factors for a period.

The prepayment characteristics of jumbo loans means a greater degree of negative convexity for WL MBSs relative to comparable agency MBSs. However, many firms (such as Salomon Smith Barney) have developed prepayment models for jumbos that take into account these characteristics,[35] so that valuation measures such as OAS reflect these specific prepayment

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[34] We say *rough* because the nuances of the distribution of borrower credits is difficult to represent in a simple table. For example, many loans in Ginnie Mae pools could be considered to be below A credit, based on LTVs, debt-to-income ratios, and so on; however, a U.S. government guarantee makes this a nonissue for investors. Also note that some Manufactured Housing borrowers may be rated A, based on criteria such as credit history and debt ratios.

[35] For a description of Salomon's WL prepayment model, see Chapter 11.

Exhibit 1.23 The Spectrum of Residential Mortgage Loans

	Credit		
	A	**Nontraditional A**	**Subprime**

Higher Loan Balances →

A	Nontraditional A	Subprime
Traditional Jumbos Average balance ≅ $325,000 Higher CA % Affluent borrowers **Major Issuers** *Countrywide, Norwest, RFC, GE Capital, Chase, Citicorp Mfg.* **Conforming Limit** **Agency MBS**	**Alt-As** Average balance ≅ $130,000, but large dispersion Investor loans Limited documentation Good credit, higher debt **Major Issuers** *Indy Mac, Norwest RALI*	Poor credit history High debt ratios **Larger Loans (B & C)** Average balance > $80,000 Higher CA % More A–, B Credits **Major Issuers** *RASC, Option One, Long Beach, New Century* **Home-Equity Loans (HEL)** Average balance ≅ $40,000–$60,000 More B, C and D credits Shorter terms Some second liens **Major Issuers** *EquiCredit, Advanta UCFC, IMC, Money Store, ContiMortgage, Gree Tree*
	Manufactured Housing (MH) Average balance. ≅ $30,000–$40,000 Lower-income borrowers *Major Issuers* *Gree Tree, GreenPoint, Associates First, Vanderbilt, Oakwood*	

RFC: Residential Funding Corporation, RALI: Residential Accredit Loans, Inc., RASC: Residential Assets Securities Corp., UCFC: United Companies Financial Corporation.
Source: Salomon Smith Barney.

characteristics. OASs on WL CMO bonds have recently been 10bp to 20bp wider than those on comparable agency CMOs.

Alternative-A Loans   The alternative-A (alt-A) sector has grown in recent years. Total issuance was about $20 billion in 1998, more than double 1997 volume, and the total outstanding volume of alt-A MBSs is about $30 billion. Salomon Smith Barney recently published a comprehensive discussion of the alt-A market,[36] so we will keep the discussion here brief.

Alt-A loans tend to be of moderately high credit quality. Although the average loan balance is not much higher than for agency loans, loan sizes vary widely with significant percentages—typically 30% to 40%—above the agency conforming limit. The loans that are below agency loan size limits may be *nonconforming* —that is, not eligible for agency pools—for a variety of reasons, the main ones being that the loans are on investor properties, are underwritten using limited or alternative documentation (for example, the borrower may be self-employed and not have a history of regular income), or are cash-out (or equity take-out) loans with a new LTV that exceeds agency guidelines for such loans. In some cases, the loans may qualify for agency pools, but the borrower may obtain a better rate through a non-agency program. On average, recent alt-A loans have been originated at about 70bp to 80bp above standard conforming loans.

The nature of alt-A loans leads to distinctive prepayment patterns:

■ Baseline speeds tend to be high, because of ongoing "curing"; that is, borrowers' situations improve so that they are able to refinance at a lower rate. This implies an ongoing stream of refinancings even if mortgage rates do not change. Dispersion in WACs tends to accentuate this phenomenon.
■ The high proportion of refinancings in total alt-A speeds leads to a short seasoning period relative to agency collateral.
■ However, sensitivity to interest rate moves tends to be lower for alt-As, because most alt-A borrowers face extra hurdles in refinancing their loans relative to standard conforming or jumbo borrowers.

These patterns imply a flatter prepayment curve for alt-As relative to conforming or jumbo loans, giving them attractive convexity characteristics.

A recent development has been increasing agency purchases of alt-A loans, as both Fannie Mae and Freddie Mac have relaxed certain underwriting guidelines in an effort to increase market share. There has been

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[36] See Chapter 12 for a more detailed discussion of the alternative A sector.

some concern that this could lead to lower alt-A rates and, hence, higher re-financings for alt-A securities. However, early indications do not seem to warrant such concerns.[37] In fact, agency involvement could actually improve the favorable convexity characteristics of new alt-A deals, as the agencies skim off the cream of the alt-A borrower pool leaving in the alt-A pools those borrowers who face the greatest hurdles in obtaining a loan.

The Subprime Sector: B and C and Home Equity Loans   The term B and C is used as a synonym for subprime loans. These are loans made to borrowers with imperfect credit histories and higher debt-to-income ratios than those allowed by the agencies. Based on the degree of these deficiencies, the loans are classified as being of A (or A–), B, C, or D credit quality, although an A rating does not by any means imply that the loan is of the same quality as agency loans. Subprime loans tend to be originated at several hundred basis points above conforming agency (i.e., prime quality) loans. However, there is no industry standard for classifying loans by credit quality, and hence, the loan rate on, for example, C loans may vary from issuer to issuer.[38] Our studies indicate that, typically, subprime lenders originate A– loans at 100bp to 200bp above agency conforming rates, while note rates on B loans tend to be about 100bp higher, and those on C and D loans are each about 150bp higher than the preceding category.

Home Equity Loan (HEL) nominally refers to a second mortgage (or lien) on a property. Indeed, at one time HEL MBSs were collateralized mostly by second liens. However, the collateral for HEL deals issued in the past several years typically has had a majority of first liens; these have constituted 75% or more of the collateral in most cases. These first liens are typically subprime loans, ranging from A– to D.

Since both B and C and HEL securities are backed by subprime loans, what is the main difference between B and C and HEL securities?[39] The main difference is in the distribution of credits. Despite the terminology, B and C deals tend to have mostly A– and B quality loans, while HEL deals tend to contain the full spectrum of credits from A– to D. This difference is reflected in typical loan sizes: The loan balance in HEL deals tends to average between

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[37] See Chapter 12.

[38] For a description of typical criteria used by a few major B and C lenders to categorize borrowers, see *"B" and "C" Borrowers: A New Frontier in the Nonagency Market,* Salomon Brothers Inc., May 1994.

[39] Apart from the fact that B and C loans tend to be labeled MBSs while HELs are called asset-backed securities (ABSs).

$40,000 to $60,000, while for B and C deals it is typically $80,000 or higher.[40] In addition, more B and C loans have prepayment penalties.

Salomon Smith Barney has developed issuer-specific HEL prepayment models based on extensive data analysis.[41] The main characteristics of HEL speeds, relative to agency collateral, are:

■ **High base case speeds,** typically averaging 25% to 35% CPR. This is mainly due to credit-curing; that is, borrowers improving their rating, and, hence, being reclassified from, say, a C to a B loan. As indicated above, such a reclassification can lower the coupon rate by up to 200bp, providing ample refinancing incentive even if interest rates do not decline.
■ **A short seasoning ramp,** because of the high proportion of refinancings in total speeds.
■ **Lower sensitivity to interest rates,** which is a result of the small loan balances and the extra refinancing hurdles faced by subprime borrowers.
■ **Higher levels of defaults,** as might be expected given the nature of the loans. Our studies indicate that annual default rates peak at about 3% on average, or more than six times typical rates on conventional agency loans.

B and C loan speeds follow a similar pattern, with minor variations resulting from the differences in loan characteristics just described:

■ Baseline speeds are a little lower (by 5% to 10% CPR). B and C borrowers have higher credit quality on average, and hence, credit-improvement related speeds play a smaller role. Prepayment penalties also help to slow speeds.
■ Sensitivity to interest rates is about the same, maybe a tad higher. The higher average loan quality and larger loan balances may be balanced by the effect of prepayment penalties.

These attributes lead to attractive convexity characteristics for MBSs backed by subprime loans. In addition, subordinate pieces of subprime collateral provide a challenging but potentially rewarding opportunity for investors.

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[40] The difference in loan balances, however, could partly be due to geographical reasons. The lenders typically termed B and C have a California concentration, while traditional HEL lenders do not.
[41] See Chapters 19 and 20 for a discussion of HELs.

Manufactured Housing Loans   Manufactured housing (MH) refers to homes constructed in a factory and transported to a land site. Although the size and quality of MH has increased in recent years, the homes still tend to be much less expensive than site-built homes. Hence MH loans tend to be much smaller than most other types of mortgage loans, with average balances of $30,000 to $40,000 in recent deals, and $20,000 or so for older deals. In addition, borrowers tend to have lower than average incomes.

These factors imply among the most favorable prepayment characteristics of all mortgage product. Indeed, prepayments on seasoned MH loans tend to be relatively stable, averaging about 12% CPR in the base case (i.e., when there is little or no refinancing incentive) and rarely rising much above 20% to 25% CPR.[42] Salomon Smith Barney recently released an MH prepayment model based on a detailed analysis of almost one million loans originated by Green Tree Financial Corporation, the largest lender in this sector. The model shows that the option costs for bonds backed by MH loans tend to be a fraction of those for comparable CMO bonds backed by agency or jumbo loans.[43]

Summary of Prepayment Characteristics   Exhibit 1.24 is a simplified guide to the effect of various loan characteristics on prepayments defaults, based on these discussions.

Commercial Mortgage-Backed Securities

The term *commercial mortgages* is used to denote loans on multifamily housing,[44] as well as loans on a variety of nonresidential property types, such as *office, retail, hotel/motel,* and various others (such as *industrial* and *nursing home*). The total outstanding amount of such loans at the end the third quarter of 1998 was about $1.25 trillion, compared with $4.3 trillion of one- to four-family mortgage debt.[45] Issuance of securities backed by commercial mortgages has grown tremendously in recent years, with about $78 billion in public issuance in 1998, compared with roughly $45 billion in 1997, and only $17 billion in 1993. The size of CMBS deals has increased,

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[42] As with subprime loans, defaults are a more significant part of the total speed for MH loans than is the case for agency loans, peaking at about 3% CPR after several years.

[43] See Chapter 21 for a more detailed description of the MH sector.

[44] Loans on one- to four-family properties are included in the agency definition of single-family mortgages.

[45] *Federal Reserve Bulletin,* February 1999, page A35.

EXHIBIT 1.24   Major Factors Influencing Prepayments and Defaults

	Refinancings			
Factor	Turnover	Rate-Driven	Other*	Defaults
Collateral and Borrower Related				
Larger Loan sizes	—	↑	↑	—
Higher Credit Score, Lower Debt	↑	—	↓	↓
More Second Liens	—	↓	↑	—
Higher LTV	↓	↓	↓	↑
Macro Economics				
Lower Rates	↑	↑	—	↓
Healthier Economy	↑	↑	↑	↓
Higher Home Prices	↑	↑	↑	↓

*Refinancings on lower credits that are insensitive to rate moves, driven by debt consolidation and credit improvement.
 Source: Salomon Smith Barney.

from an average of just over $400 million in 1997, to almost $900 million in 1998, reflecting a trend toward deals backed by many loans from several issuers and investor interest in secondary market liquidity.[46]

Most commercial loans have payments based on an amortization schedule of 25 to 30 years, but have a balloon payment due, usually after 10 or 15 years. Prepayment risk is low compared to that for other mortgage sectors. Commercial mortgage loans typically have severe restrictions on prepayments, such as a complete prohibition (or *lock-out*), a *yield maintenance* provision (which means that if the loan is prepaid, the borrower has

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[46] The term *fusion deal* is used to refer to transactions containing some large loans; the industry convention currently is to define a fusion deal as one where an individual loan is more than 10% of the collateral, or loans of greater than $50 million constitute more than 15% of the deal.

to compensate the lender for the loss of an above-market coupon), *defeasance,*[47] or a gradually declining penalty proportional to the loan balance (e.g., a "5-4-3-2-1" schedule, which means 5% for a year, then 4% for a year, and so on). These penalties are often combined; for example, a loan may have a lock-out period of five years, followed by a declining penalty proportional to the loan balance for the next five years. Such penalties, combined with the considerable expense and time involved in refinancing a commercial loan, means that CMBSs are unlikely to be exposed to a sudden spike in refinancings, at least during the prepayment penalty period.[48]

CMBSs constitute an unusual sector in the mortgage market, combining features of both MBSs and corporate bonds. A key difference between residential and commercial mortgage loans is that the latter are non-recourse; that is, if the borrower defaults, the lender cannot seize any other assets of the borrower. In other words, the income-producing capabilities and value of the underlying asset is key to CMBS analysis. Hence, evaluation of the credit risk in CMBSs depends on specific property characteristics, such as the ability to make mortgage payments (a commonly used measure is the *debt service coverage ratio* (DSCR), which is the net operating income divided by debt payments), and the ability to refinance the loan at the balloon date (hence rating agencies attach importance to initial LTV). In addition, general relevant business trends, such as apartment or office vacancy rates, have to be analyzed.

For senior CMBS classes, the likelihood of losses from defaults is negligible, even under extreme scenarios, because of the stringent subordination amounts required by the rating agencies; typically, there is 28% to 30% of credit support for triple-A CMBS classes, compared to 10% or less for triple-A bonds from non-agency deals backed by prime quality, single-family loans. In fact, spreads on senior CMBS classes currently seem to be driven primarily by capital market developments. An example is provided by the events in the fall of 1998, when CMBSs spreads widened with other spread product despite good commercial real estate fundamentals. Since then, CMBSs spreads have tightened sharply as the fixed-income markets have stabilized. However, as has been the case historically, they still offer substantially higher spreads relative to comparable quality corporate bonds, even though one could argue that CMBSs backed by a diversified pool of

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[47] A defeasance provision allows the borrower to obtain a release of the mortgaged property by pledging U.S. Treasury securities whose cash flows equal or exceed that of the mortgage loan.

[48] In fact, for CMBSs the term *refinancing risk* typically refers to the possibility that the borrower will not be able to refinance the loan at the balloon date.

loans have less credit uncertainty and event risk than a similarly rated corporate bond.[49]

1.7 MBS MARKETS OUTSIDE THE UNITED STATES

An important trend over the past ten years has been the development of secondary mortgage markets outside the United States. The factors behind this trend are similar to the ones that drove the development of the market in the United States. At a governmental and social policy level, there is a desire to replicate the perceived success of the United States in making housing finance cheaper and more easily available to home buyers. For lending institutions, competitive and regulatory pressures have grown for efficient balance sheet management, and securitization of assets facilitates this process.

The largest MBS market outside the United States, and the one with the most potential, is Europe, and we discuss the European market in more detail later. Other countries with developing secondary markets include **Canada,** where the market has grown steadily since its inception in 1987, helped by the establishment of a Ginnie Mae-type entity, the Canadian Mortgage and Housing Corporation; **Australia** and **New Zealand,** where a total of about $18 billion in loans were securitized in 1997 and 1998; **Hong Kong,** where an agency-type entity, the Hong Kong Mortgage Corporation, has been established; and **Argentina,** where several MBS deals have been issued. While these markets are small compared to that in the United States, a potentially large market exists in **Japan,** which has about $1.5 trillion in mortgage loans outstanding and where an MBS deal was recently priced. There is pressure on Japanese banks to remove loans from their balance sheets, to meet capital adequacy requirements, and hence, a continuing stream of securitizations is expected.

The Danish MBS Market

Before discussing the development of the European MBS market, we note that a well-established secondary mortgage market already exists, in Denmark. In fact, the Danish market is older than the U.S. MBS market: A mortgage credit system has been in existence in Denmark for 200 years. Although there are

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[49] This is illustrated by the fact that investors prefer CMBS deals backed by a large number of small loans to those backed by a few large loans. Part Six of this book provides a comprehensive description of CMBSs.

other established types of mortgage bonds in Europe, notably the *Pfandbrief* sector in Germany,[50] Danish MBSs are the closest to U.S. pass-through securities in cash-flow characteristics.[51] They are mostly fixed-rate, level-pay loans (called annuity loans in Denmark), with original maturities of 10, 15, 20, or 30 years, and can be prepaid without penalty at any time. However, mortgage payments are quarterly rather than monthly. In addition, residential and commercial mortgage loans are mixed in the same pools.

The amount of outstanding Danish fixed-rate MBSs was DKr 970 billion at the end of the second quarter 1998, or about $150 billion, a remarkable amount for a nation of only five million people. Danish mortgage pools (or series) tend to be large in size, typically $1 billion or more initially (some issues are more than $10 billion). This size is achieved by keeping a series open for up to three years; that is, new loans can be put into the pool anytime during a period of three years.

Prepayments in Denmark show extreme efficiency, because of very low refinancing costs, a national awareness of refinancing opportunities (a strong media effect), and the ability to prepay discount loans at market value (rather than at par). However, as in the United States, considerable resources have been devoted to developing prepayment and OAS models to capture prepayment risk.[52]

Securitization in Europe

The first MBS deals in Europe (not counting the Danish MBS market) were done in the mid-1980s, with United Kingdom mortgages as collateral. There

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[50] *Pfandbriefs* are collateralized bonds, with a total market size of close to $1 trillion, of which a quarter are backed by residential mortgages (although because the LTV cannot exceed 60%, only a fraction of German mortgages are eligible for *Pfandbriefs*). However, prepayments are not allowed, and even if a loan is prepaid, the issuer typically does not pass on the prepayment to investors. For a description of the sector, see *The Jumbo-Pfandbrief and its Future,* Udo Herges, Salomon Smith Barney, July 1998.

[51] For an introduction to Danish MBSs, see *Mortgage Bonds,* by Den Danske Bank, September 1998. The figures on the Danish market are taken from this publication.

[52] There is one difference in the way prepayments are passed through to investors: Instead of the pro rata system used in the United States, prepayments in Denmark are distributed by a lottery system, each bond (nominal value Dkr 1,000) being one lot. Investors with large holdings would expect to see prepayments on their bonds close to the rate for the pool (or series), given the law of averages, but smaller investors may see deviations.

EXHIBIT 1.25 European MBS/ABS Issuance by Asset Type, 1997 and 1998 (Dollars in Billions)

Asset Type	1997	% of Total	1998	% of Total
MBS	$11.0	24	$22.7	49 %
CMBS	2.6	6	2.6	6
CBO/CLO	14.6	32	8.5	18
Other ABS	17.3	41	12.9	27

Source: Moody's Investors Services.

have also been securitizations of other asset-classes, such as credit cards and auto loans. According to estimates by Moody's Investors Services, annual issuance of European MBS/ABS was less than $10 billion until 1996, when it jumped to $30 billion, then further increased to $45.4 billion in 1997. Volume for 1998, however, was about the same as 1997, at $46.6 billion, as the flight to quality last fall led to a dramatic widening in ABS spreads and reduced issuance to a trickle. Despite the increase in issuance in 1996 and 1997, volume is still low relative to the United States and relative to the amount of mortgage loans outstanding in Europe. However, as the jump in volume in the past few years implies, many of the impediments to securitization have been diminishing, and volume is expected to surge in coming years.

Mortgages continue to form the bulk of collateral for European deals. Exhibit 1.25 shows a breakdown of European issuance by collateral type for 1997 and 1998. The total outstanding volume of European MBS/ABS has been estimated to be about $130 billion,[53] of which perhaps half are MBSs.

For MBSs, the United Kingdom has been the major source of collateral; in fact, until the past year or two, three countries (the United Kingdom, France, and Spain) provided the collateral for almost all MBS issues. However, in a sign of the gradual progress of securitization, in 1998 seven other countries were also represented in MBS deals (although the United Kingdom, France, and Spain still accounted for two-thirds of the collateral). A notable entry into the MBS market was Germany, the largest mortgage market on the continent in terms of amount of loans outstanding, where three large deals were issued in 1998.

Raw Material: Amount of Loans Outstanding　What is the volume of European mortgage loans outstanding? A study by a consulting firm estimated that "retail" mortgage loans outstanding in 1996 totaled about $2.6 trillion in

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[53] These estimates exclude Danish MBSs and mortgage bonds, such as *Pfandbriefs.*

16 western European countries.[54] This compares with $3.8 trillion in one-to four-family mortgages outstanding in the United States at the end of 1996. However, the term retails, according to the study, "does not include loans to self-employed businessmen," an exclusion that would knock out a significant fraction of the loans in the United States. We can probably conclude that the size of the primary mortgage market in western Europe is comparable to, or a tad smaller than, the U.S. mortgage market.

Why Has the European MBS Market Not Developed Faster? Despite steady issuance since the mid-1980s, securitization volume in Europe has lagged U.S. rates, for a variety of reasons:

■ Many institutions have not faced strong incentives to remove assets from balance sheets, due to favorable funding rates and excess capital.
■ The severe recession in Europe in the early 1990s led to a sharp drop in loan originations, further diminishing pressure on balance sheets.
■ A lack of legal and regulatory frameworks hinder securitization.
■ Few analytic tools and an infrastructure exist for timely reporting of deal information to investors.
■ A diversity of mortgage terms and conditions, such as prepayment penalties, from country to country diminish the appeal of MBSs backed by loans from one country to investors in other countries.
■ Currency differences hindered cross-border transactions in the past.
■ Many European investors have tended to focus on sovereign debt, rather than spread products.

Faster Growth Expected Many of these impediments to growth have been diminishing, as indicated by the substantial jump in issuance starting in 1996 mentioned earlier. The general expectation is for more rapid development of the European MBS and ABS markets over the next several years. Several factors are expected to contribute to this trend:

■ The introduction of the Euro is expected to have a major impact, as it will gradually eliminate much of the existing sovereign bond markets, shift investor attention to spread products, especially MBSs and ABSs because of their high credit quality, and eliminate currency concerns.
■ In the past few years, various countries have made legal and regulatory changes that facilitate securitization, and this trend is expected to continue.

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[54] *European Mortgages Report,* Datamonitor, 1997.

■ Competitive and regulatory pressures on institutions are mounting, leading to more focus on measures such as return-on-equity and on efficient balance sheet management.
■ Gradual improvements in MBS deal information reporting systems, and more familiarity with cash-flow characteristics, both contributing to increasing investor comfort levels with MBS and ABS products.[55]
■ A continuing broadening of the types of assets being securitized—for example, subprime mortgages, student loans, soccer receivables, pub leases, and so on.

However, before the European MBS and ABS markets approach United States levels (more than $3 trillion in MBSs and ABSs outstanding), some impediments have to be removed. One is the variety of rules and regulations (or lack of them in some cases) governing securitization from country to country. Some securitization professionals expect that with a common currency and a single central bank, standardization will occur, although it may take a while. Second, and perhaps most important, there is no equivalent of Ginnie Mae, Fannie Mae, or Freddie Mac in Europe. These entities have not only played a critical role in the growth of the secondary mortgage market in the United States; the establishment of Fannie Mae in 1938 by the federal government also led to standardization of mortgage terms and underwriting practices in the United States. The establishment of a pan-European housing finance agency would likely have a similar effect in Europe.

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[55] As an indication of this trend, we note the Bond Market Association (formerly the PSA), a trade group in New York representing fixed-income dealers, has recently set up a European Securitization Forum to "promote the continued growth and development of securitization throughout Europe."