OXFORD

THE HANDBOOK OF MORTGAGE-BACKED SECURITIES

7TH EDITION

EDITED BY

FRANK J. FABOZZI

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Seventh Edition

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Preface

The seventh edition of *The Handbook of Mortgage-Backed Securities*, the first revision following the subprime mortgage crisis, is designed to provide not only the fundamentals of these securities and the investment characteristics that make them attractive to a broad range of investors, but also extensive coverage of the state-of-the-art strategies for capitalizing on the opportunities in this market. The book is intended for both the individual investor and the professional manager.

To be effective, a book of this nature should offer a broad perspective. The experience of a wide range of experts is more informative than that of a single expert, particularly because of the diversity of opinion on some issues. I have chosen some of the best-known practitioners to contribute to this book. Most have been actively involved in the evolution of the mortgage-backed securities market.

Asset managers must justify their management and transaction costs to clients. Consequently, all asset managers eventually must demonstrate to their clients how much *value* they've added to portfolio performance above and beyond what could have been achieved by employing a lower-cost, buy-and-hold strategy. As the editor of *The Handbook of Mortgage-Backed Securities,* I am effectively the asset manager of the assets of this book—the chapters. The seventh edition must justify to my current clients (those who purchased the sixth edition of the *Handbook*) why they should not follow a buy-and-hold strategy of simply continuing to use the sixth edition and reduce advisory fees and transaction costs (i.e., the cost of this book). In short: What value has been added to the seventh edition?

The sixth edition was published in 2006, one year prior to the subprime mortgage crisis. The events and legislation following the subprime mortgage crisis made it necessary to update the *Handbook.* The number of chapters has been reduced from 55 chapters to 35 chapters. Of the 35 chapters in the seventh editing, 17 are new, with the balance of the chapters substantially revised from the previous edition. Consequently, this book can be characterized as a new book, reflective of the dynamic changes that have occurred in this market in terms of new product development, advances in technologies, and legislation since the publication of the sixth edition in 2006.

Acknowledgments

I am grateful to the contributors to this book for allocating their limited time to the writing of the chapters. Several organizations contributed multiple chapters to the *Handbook*.

I am particularly grateful to Andrew Carron at NERA for identifying staff members to contribute chapters and Barbara Hirsh at NERA who was kind enough to coordinate the submissions, including the time-consuming process of obtaining the necessary permissions for the six NERA-contributed chapters.

Bill Berliner did a masterful job of delivering seven chapters to the book, along with Anand Bhattacharya who coauthored six of those seven chapters.

Frank J. Fabozzi

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PART I

BACKGROUND

CHAPTER 1

MORTGAGE LOANS TO MORTGAGE-BACKED SECURITIES

BILL BERLINER, ADAM QUINONES, AND ANAND BHATTACHARYA

After reading this chapter you will understand:

- the nature and attributes of mortgage loans;
- the history of the US government's involvement in the mortgage market;
- different types and classifications of mortgage loans;
- the mortgage lending industry;
- the loan underwriting process and the concept of an originator pipeline;
- the nature of mortgage cash flows;
- the rationale for the development of markets for mortgage-backed securities;
- the different government agencies and entities facilitating the MBS market;
- prepayments and their impact on MBS performance;
- the different markets in which MBS are issued and traded;
- different types of structured MBS transactions and tranches;
- the links between the mortgage and MBS markets.

Mortgages are loans used to finance the purchases of homes and other real estate. The concept of a "mortgage" can be traced as far back in history as the fifteenth century in English common law. The successes and failures of mortgage markets have sparked and/or exacerbated well-documented economic booms and busts, most recently the financial crisis of 2007–8 that led to the so-called Great Recession. While mortgages are now relied upon globally as a mechanism for the purchase of housing and real property, the mortgage market in the United States is by far the largest and most developed housing finance system in the world. The growth of the US mortgage market also spawned the creation and development of the mortgage-backed securities (MBS) market, one of the largest and most active sectors in global finance.

This chapter offers an overview of how the modern US mortgage market was formed and describes how it operates. We discuss its history and development, as well as the attributes associated with different mortgage products. We then address the MBS market; we examine why and how it developed, how securities are created, and how they are traded in the financial markets.

Mortgages have played a key role in the achievement of part of the "American Dream" since the 1930s. Prior to that, mortgages were primarily short-term loans with high down-payment requirements. Lending institutions sourced funding and lent almost exclusively within their geographic footprints, and loan pricing was disjointed and highly dependent on local economic conditions. It wasn't until the Great Depression, and the resulting economic and regulatory reforms under President Franklin Roosevelt's New Deal, that the mortgage industry began to be formally integrated into the country's financial infrastructure. Beginning with the National Housing Act enacted in 1934, Congress passed legislation creating the Federal Housing Administration (FHA), the Federal National Mortgage Association (FNMA or Fannie Mae) in 1938, the Veterans Administration in 1944, the Government National Mortgage Association (Ginnie Mae or GNMA) in 1968, and the Federal Home Loan Mortgage Corporation (FHLMC or Freddie Mac) in 1970. While they differ in legal structure and reach, these government enterprises and agencies form the foundation of the modern US mortgage market.

The MBS market first developed in the late 1970s with the issuance of bonds backed by mortgage assets held by a few lenders. The early 1980s saw the development of the "agency passthrough market" in the form of the issuance and trading of MBS created under the auspices of Ginnie Mae (a government-owned corporation which resides within the Department of Housing and Urban Development (HUD)), along with Freddie Mac and Fannie Mae. The latter two were created as "government-sponsored enterprises" or GSEs, a hybrid form of federally regulated but privately owned corporation. Another key development was the implementation of Rule 415 by the Securities and Exchange Commission (SEC) in 1982, which allowed for so-called shelf registration of securities issues. This facilitated the issuance of non-agency mortgage-backed securities and created a method for liquefying loans that were not covered under any government entity or program. The resulting growth and development of the MBS market facilitated the expansion of a national mortgage market where bond market investors provided much of the funding for mortgage lending.

Both the mortgage and MBS markets are enormous in size and scope. Total residential mortgage debt outstanding in the US first crossed the $1 trillion mark in 1978, and was in excess of $13 trillion at the end of 2014. Gross issuance of US mortgage bonds totaled $2.1 trillion in 2014, while trading volume averaged $231.1 billion per day in the fourth quarter of 2014. Since the year 2000, cumulative MBS issuance has been exceeded only by issuance volumes in the US Treasury market.

Mortgage Loans

As the term is commonly used, "mortgages" are loans made to households or firms for the purchase of housing, land, or other real property. A combination of a "promissory note" and evidence of title (e.g., a deed of trust), a mortgage represents a legal contract requiring the borrower to make a predetermined series of payments in exchange for upfront funds by a lender. This pledge to repay the debt relies upon the underlying real property as collateral in the event of default. If a homeowner (the *mortgagor*) fails to pay the lender (the *mortgagee*), the lender has the right to foreclose on the loan and liquidate the property to repay the debt they are owed. A mortgagor who fails to make a mortgage payment is said to be *delinquent*.

Lien status determines the priority of principal recovery in the event of default by the mortgagor. Most mortgages originated in the US take a first lien position, implying that the lender would have first right to any proceeds generated from the liquidation of the underlying collateral. A second lien naturally implies that a mortgagor will be given access to proceeds of collateral liquidation only after the first lien is paid off. The availability of second liens gives borrowers supplementary funding options when buying or refinancing their home. Motivations for taking out a second lien range from difficulties meeting home purchase down-payment requirements to consolidating other non-mortgage debts such as student loans, medical bills, or credit cards. Another common reason for taking out a second lien is to avoid mortgage insurance when the borrower is unable to meet strict home purchase down-payment requirements, typically 20% of the property's value. In this transaction, the first and second lien mortgages are closed concurrently by the same lender, and is referred to as a "piggyback loan."

Mortgage insurance (MI) is commonly used when borrowers cannot make a 20% down-payment and second lien financing is not utilized. MI provides a financial backing that protects the lender against losses arising from borrower default. The mortgage insurance provider covers a portion of the loan (typically, the amount in excess of 80% of the home's appraised value) in return for the payment of a mortgage insurance premium. Depending on the loan, either the lender or the homeowner pays for the insurance policy, with the mortgage lender as the beneficiary. MI can be canceled if the borrower's loan-to-value (LTV) ratio drops below 80%.

Mortgage Metrics and Attributes

Every mortgage has a number of attributes and metrics. Loans always carry a specified *note rate*, which is the rate of interest to be paid by the borrower on the loan. The note rate can either be fixed for the life of the loan, or can adjust periodically. The note rates on "adjustable-rate" mortgages or ARMs are calculated based on the level of a published index (such as LIBOR) plus a margin fixed for the life of the loan. The loan's note specifies the index and margin to be used, along with other details such as how often the rate changes (or "resets"), the specific day that the index is referenced, the timing of the first reset, and caps and floors that limit how much the rate can change at different times.

In addition to the note rate, every loan has both a defined *term* and a rule or rules that determine how the asset will pay down or *amortize*. While any term can technically be specified, most loans have terms of either 30 years (360 months) or 15 years (180 months). The majority of mortgage loans are originated as "fully amortizing" loans. This means that the payment consists of both principal and interest components; the payment is calculated such that the loan's principal is fully amortized over the life of the loan.

One feature of mortgages that impacts their behavior is that they can be retired early (or *prepaid*) at the option of the borrower. Most prepayments pay down the loan in the form of a single payment to the holder of the loan, and take place either when the underlying property is liquidated or the borrower refinances into a new loan. Loans are also considered to be prepaid if the borrower defaults on the loan.

In addition to the common factors of rate, term, and amortization, the mortgage market has a number of additional dimensions by which products can be subdivided. These attributes include:

- *Government guarantees*. Most loans are not explicitly guaranteed by the federal government and are considered "conventional" mortgages. However, a number of government agencies provide loan guarantees for certain types of homes and/or borrowers, such as economically disadvantaged borrowers, veterans, and homes in rural areas. These are considered "government loans" where the government offers various forms of direct credit support to the holder of the loan.
- *Balance classification*. Both Ginnie Mae (a government agency housed within HUD) and the GSEs (i.e., Fannie Mae and Freddie Mac) provide additional support for the development and maintenance of the market for mortgage-backed securities, as we will discuss later in this chapter. By statute, such support is limited to loans with balances below a certain threshold. This "conforming balance" for single-family homes was originally $85,000 in 1985 and is recalculated annually based on changes in national home prices. The conforming limit has been unchanged at $417,000 since the onset of the financial crisis in 2007; the government determined that lowering the limit due to falling home prices would not constitute good policy in the face of a severe economic slump. In fact, legislation passed during that period created a higher limit or "ceiling" in excess of the conforming limit for loans made in certain "high-cost" areas. These ceilings were designed as percentages of the conforming limit, and were originally 175% of the conforming limit for conventional loans (and 150% of the limit for government loans). The ceiling for these *super-conforming* loans is currently 150% of the conforming limit, or $625,500, for all single-family loans. (There are separate larger limits that apply for two- to four-family properties.)
- *Credit classification*. Mortgage loans have traditionally been limited to higher-quality borrowers with substantial financial assets and strong credit histories, who

are able and/or willing to provide documentation for their financial situation. Starting in the 1990s, however, loans were increasingly made to weaker borrowers (i.e., borrowers with low credit scores and limited financial reserves), along with loans to self-employed borrowers and others who found it difficult to document their income and assets. Initially, the two forms of non-traditional lending were classified as *subprime loans* (to distinguish them from traditional so-called prime loans) and "alternative-A" (or *alt-A*) loans. (The latter terminology implied that the loans were of "A-quality" but had alternative documentation standards.) By the mid-2000s, however, the lines between the two terms had blurred to the point where many loans considered subprime also had limited documentation, and many alt-A loans had weak credit attributes. As a result of the financial crisis that culminated in 2008, however, the market has reverted to a regime where the vast majority of loans originated are once again fully documented loans to high-quality borrowers. (The tightening of lending standards, in fact, raised concerns that many borrowers who would traditionally have been viewed as acceptable credit risks were being excluded from the mortgage market, depressing home prices and inhibiting economic growth.)

- *Regulatory treatment*. The Dodd-Frank Act (DFA) passed by Congress in 2010 was intended to tighten lending standards and regulatory oversight of consumer lending in the wake of the excesses that led to the financial crisis. One element designed to codify mortgage lending and loan quality standards was the creation of a classification scheme for residential mortgages. Lenders originating loans classified as "Qualified Mortgages" (*QM*) were given some protection from the recourse traditionally used (and misused) by loan servicers and investors if loans eventually go into default and foreclosure. For a mortgage to be considered a QM loan, it must be underwritten to fairly rigid standards that measures the borrower's ability to repay the debt throughout its term, and must use a traditional fully amortizing payment scheme for a maximum term of 30 years.

The Loan Application and Underwriting Process

Once a mortgage application is submitted by a borrower, it is considered to be part of the lender's "pipeline" of applications. The borrower can opt to set the loan's note rate at either the time the application is filed or at some time prior to the loan's closing. Prior to setting (or "locking") the rate, the loan is considered to be part of the *uncommitted pipeline*; since the rate is not set, there is no interest rate risk to the asset and it thus does not need to be hedged. Once the loan is locked, however, it joins the *committed pipeline* and the associated interest rate risk can be hedged.

After it enters a lender's pipeline, the loan must be evaluated for credit quality or "underwritten." Loan underwriting is a multi-step process that can take a month or longer. Depending on how the loan is progressing through the process, lenders will assign a "closing ratio" to the loan. The closing or "pull-through" ratio weights each loan's face value by the probability that the loan will ultimately close. The likelihood of any loan closing is based on where the loan stands in the underwriting process at that point in time, along with changes in market mortgage rates after the rate is locked. For example, a lender might assign a 75% closing ratio to a new application, which might then increase to 85% once the loan is approved and 95% once closing documents are drawn. Alternatively, since applicants can cancel their applications prior to closing, the expected probability of closing declines as market rates drop and borrowers consider seeking a better deal with another lender.

The loan underwriting process is designed to assess two separate but related components:

- evaluating the borrower's ability and willingness to service the loan (i.e., make principal and interest payments in a timely fashion) even under stressful financial conditions; and
- ensuring that the underlying property's liquidation value is sufficient to pay off the remaining amount of the loan if the borrower were to default on the obligation.

There are a number of metrics and processes that are used to evaluate the above components.

Credit Reports and Scores

A borrower's credit score is a number that quantifies a potential borrower's creditworthiness using a variety of factors. As of 2014, FICO scores are determined by five factors: (1) payment history (35%); (2) amounts owed (30%); (3) lengths of credit history (15%); (4) types of credit in use (10%); and (5) new lines of credit (10%). A higher score indicates a better credit profile and implies that an applicant is more likely to make timely payments on his/her debt obligations.

The three credit bureaus that provide credit scores as well as detailed credit reports are Experian, Equifax, and TransUnion. These credit reporting agencies (CRAs) rely on the data and metrics listed above to calculate credit scores using models provided by *FICO* (formerly Fair Isaacs Corporation). Credit scores from the three CRAs are not identical because each CRA possesses different amounts of information about the borrower. FICO scores range from 300 to 850. A score of 750 or higher is currently considered by lenders to be excellent; 720 to 750 is very strong; 680 to 720 is good; and below 680 is considered fair but potentially problematic. A score below 620 is poor and suggests that the applicant is likely to default on his/her obligations.

Debt-to-Income Ratios

Debt-to-income ratios (DTIs) measure monthly debt service payments as a percentage of monthly gross (i.e., pre-tax) income. The two most common metrics are front and back ratios. The *front ratio* measures the projected total monthly cost of home ownership (principal and interest on the loan along with property taxes and insurance, or PITI) as a percentage of pre-tax income, with 28% the highest level allowed by many loan programs. The *back ratio* is calculated using the PITI and adding the payments on consumer debt (including auto loans, credit cards, and student loans). Most loan programs limit the back ratio to a maximum of 42%.

Documentation Style

A loan program's *documentation style* dictates how extensively a borrower needs to provide proof of their available income, assets, and employment status. The most common documentation style, and one that became virtually mandatory after the financial crisis, is the *full documentation* loan. Applicants need to provide figures outlining total income and account balances, and also must supply the lender with pay stubs, bank and account statements, and tax returns to support their claimed income and assets.

Prior to the financial crisis, it was common for lenders to offer loan programs that did not require income or assets to be verified; these were called *stated income* and/or *stated assets* programs, since the borrower supplied these metrics on their application but did not have to provide documentation such as pay stubs and bank statements. An even more relaxed form did not require the borrower to disclose any income or asset figures. These were called *NINA* loans (i.e., "no income/no assets"). The very high default rates experienced for loans with relaxed documentation standards made full documentation virtually mandatory after the financial crisis.

Loan-to-Value Ratios

Loan-to-value ratios (LTVs) measure the requested loan amount as a percentage of the appraised value of the property. LTVs are used in a number of ways. They allow underwriters to estimate the likelihood that proceeds from the liquidation of the underlying property will cover the loan's outstanding principal balance, especially if the property's value declines. Recent experience also indicates that the relative size of a borrower's equity position is negatively correlated with their likelihood of defaulting on the loan, i.e., the larger the equity position the less likely they are to default and forfeit their equity. However, there are a number of types of LTVs used in the underwriting process. The term "LTV" generally measures the ratio of the first lien to the home's value. For transactions where additional liens either exist or are contemplated, lenders will also calculate a "Combined" LTV (also called the *CLTV*). A proposed loan for $80,000 on a $100,000 property would have an 80% LTV; if the transaction included a 10% second lien as a piggyback loan, the loan would still have an LTV of 80% but a CLTV of 90%, reflecting the greater risk associated with the more leveraged transaction.

The Mortgage Lending Industry and Lending Institutions

A mortgage lender's function is to provide funds for the purchase or refinancing of real estate. This function is carried out in the primary mortgage market. The process of originating a mortgage leads to the creation of two income-generating commodities: (1) the loan itself, and (2) the right to *service* that loan. Servicing a loan involves the fairly mundane processes associated with collecting and processing payments, along with those associated with foreclosing on seriously delinquent loans, liquidating the properties, and distributing the proceeds for loans that go into default. *Originators* writing mortgages in the primary market can either hold the loans on their balance sheet or sell them in the secondary market as whole loans or mortgage-backed securities. They can also retain the right to service those loans for a fee or sell that right to another firm for immediate profit or *gain on sale*. The fee for servicing the loan is paid out of the loan's interest rate. Lenders can choose either to act as the servicer of their loans or hire a subservicing firm to carry out the various functions on their behalf.

The mortgage industry is highly competitive and populated by a large variety of firms and institutions. They can be broadly classified as either *depositories* or *mortgage bankers*.

Depositories

Commercial banks, thrifts, and their subsidiaries and affiliates make up a large proportion of the loan origination industry. Lending units within depositories (such as commercial banks, thrifts, and credit unions) can either hold mortgages in their portfolios (or in the portfolios of their parents) as assets, or can sell their production in the form of loans or securities. The ability of depositories to create their own liquidity by converting short-term deposit liabilities into long-term balance sheet assets is considered their biggest competitive advantage (as it relates to their mortgage lending activity). As banks and thrifts are motivated by their ability to maximize their shareholder's net worth without taking on excessive risks, many institutions limit their portfolio purchases to shorter-duration loans, such as ARMs, that have less interest rate and yield curve risk. Many such lenders will also sell large amounts of their production into the capital markets in the form of MBS, as these activities create supplementary non-interest income. Mortgage lending activities also provide these institutions with cross-selling potential for related services, such as retirement planning and personal investment management, which tends to enhance their overall retail financial services franchises. Their lending and distribution activities, however, are often indistinguishable from those of the independent mortgage bankers discussed in the next section; in fact, it is useful to view them as mortgage bankers that also have the option of retaining loans that fit their return and risk parameters.

Independent Mortgage Bankers

Mortgage bankers are another prime source of housing finance liquidity. Unlike depositories, independent mortgage bankers do not collect deposits to facilitate lending activities, and typically don't hold loans as investments. Their profitability is driven through "originate-to-sell" lending. In this business model, the mortgage banker directly underwrites and closes loans for immediate sale into the secondary market, often to another lender (a *correspondent*). Short-term funding to close the loan is often obtained through a *warehouse lending agreement* with another financial institution. This short-term debt liability is quickly extinguished using proceeds generated through sales of whole loans or mortgage securities in the secondary market. (Many mortgage bankers create their own mortgage-backed securities through the processes discussed later in this chapter.) While the recurrent exercise of originating and selling loans serves as a self-funding mechanism, it leaves independent mortgage bankers vulnerable to sudden fluctuations in loan production volume (due to a sudden sharp interest rate increase, for example), as it is difficult and expensive to quickly increase or decrease staffing levels. This implies that the success or failure of an independent mortgage banker is highly dependent on their ability to achieve economies of scale without sacrificing profitability.

There are significant variations across institutions in the practical execution of the mortgage banking business model. Mortgage bankers can sell their loan production to other correspondent lenders; they can buy closed loans from other lenders to supplement their own originations (i.e., act as correspondent lenders); they can open agreements to underwrite and fund loans originated by mortgage brokers (*wholesale lending*); or they can originate their own loans for sale into the secondary markets (*retail lending*). Variations in the operational strategy of independent mortgage bankers are driven by sources of funding, the size and scale of the lenders' sales forces and operations, their ability to accept and manage the financial risks associated with market fluctuations, and their ability to market and distribute their production. More recently, the extensive post-crisis regulatory changes and reforms have incentivized new types of firms to play more active roles in the independent mortgage banker space. Real estate investment trusts (REITs), hedge funds, insurance companies, money managers, and pension funds have all found ways to participate more broadly in the origination supply chain.

Whether classified as depositories or mortgage bankers, all lenders selling loans into the secondary markets must decide, among a variety of options, the form in which the loans will be sold. The decisions can be broadly classified as (1) selling loans to a correspondent lender; (2) selling loans directly to the GSEs (assuming they meet Freddie Mac and Fannie Mae requirements); or (3) creating and selling mortgage-backed securities on their own. In the latter case, conforming loans will be securitized (or *pooled*) under the auspices of the GSEs, while nonconforming loans can be securitized through non-agency or *private-label transactions*. These considerations are discussed in more depth later in this chapter.

Government-Sponsored Enterprises and Government Housing Agencies

No discussion of mortgages is complete without a thorough evaluation of the government's various direct and indirect interventions in the mortgage market. The mortgage market as it exists today is a product of various public policy measures and programs intended to promote home ownership that date back to the 1930s. A key component of the New Deal was the passage of the National Housing Act in 1934, which created the Federal Housing Administration (FHA) as a national mortgage insurance program. In 1938 the act was amended to charter the Federal National Mortgage Association (FNMA, which is today's Fannie Mae), which created liquidity for lending institutions by purchasing and holding loans insured by the FHA. The Veterans Administration was then created by the "Servicemen's Readjustment Bill" in 1944 to insure loans made to veterans. Fannie Mae began buying VA-insured loans in 1948. The "Housing and Urban Development Act" of 1968 both reorganized FNMA into a for-profit, shareholder-owned company regulated by the HUD and created the Government National Mortgage Association (GNMA, or currently Ginnie Mae). Ginnie Mae was formed to create liquidity for "government loans," i.e., loans insured by the FHA, the Veterans Administration (VA), and the US Department of Agriculture (USDA). Lastly, the Federal Home Loan Mortgage Corporation (FHLMC, or Freddie Mac) was founded in 1970 by the "Emergency Home Finance Act" to further expand secondary market liquidity and help thrifts manage their interest rate risk.

While Ginnie Mae, Fannie Mae, and Freddie Mac are often discussed collectively as "the Agencies," it is important to understand the different structures and roles of these three entities. As described on its website, Ginnie Mae "remains a self-financing, wholly owned U.S. Government Corporation within HUD." As such, securities issued by Ginnie Mae are fully and explicitly guaranteed by the taxing power of the US government. Fannie Mae and Freddie Mac, by contrast, are "government-sponsored enterprises," a unique hybrid form of public–private corporation. While their charters were created by Congress and they are regulated by the US government, their securities only carry an implied government guarantee.[1] While all three organizations empower qualified lenders to create securities under their umbrella by essentially swapping packages of loans for pools, the two forms of agencies operate differently. Fannie Mae and Freddie Mac have the ability to buy loans directly from lenders through their "cash windows" and either retain them in their portfolio (subject to constraints) or create and sell securities. (Such securities are functionally the same as those created directly by originators.) The GSEs also have the ability to issue debt to fund their operations. Finally, Fannie and Freddie effectively make markets in excess servicing by either "buying up" or "buying down" a loan's net rate in order to facilitate pooling (as we describe later in the section on "best execution"). By contrast, Ginnie Mae does not buy loans, nor does it issue mortgage-backed securities; its role is solely to certify pools backed by government loans that originators issue and sell into the secondary markets. Ginnie also does not offer to buy up or buy down the net rates on loans, which makes the pooling of loans into Ginnie pools somewhat less flexible.

Mortgage Cash Flows

A brief discussion of both the mechanics of mortgages as well as the factors impacting them will be useful in understanding MBS and their behavior.

[1] When the GSEs approached insolvency in 2008, the GSEs were placed into conservatorship by the government, which eventually injected almost $180 billion into the two corporations before they returned to profitability. At this writing, they remain in conservatorship, with their ultimate futures still unclear.

Principal and Interest Payments

As noted previously, most mortgages are “fully amortizing” loans. This means that the payment is calculated such that the loan will be fully paid off at maturity. The payment can be calculated by first computing a *mortgage payment factor* using the following equation:

$$\text{Mortgage Payment Factor} = \frac{\text{interest rate}\,(1+\text{interest rate})^{\text{loan term}}}{(1+\text{interest rate})^{\text{loan term}}-1}$$

where the interest rate is the monthly rate (i.e., the note rate divided by 12) and the loan term is quoted in months. For example, a 30-year loan with a note rate of 4.5% (or a 0.375% monthly interest rate) would have a payment factor of 0.005066. On a $200,000 loan, therefore, the monthly payment would be $1,013.[2] However, the distribution of the payment into principal and interest components evolves over time. In the example, $750 of the payment is dedicated to the interest portion of the loan in the first month, with the remaining $263 allocated to pay down the loan’s principal. (The remaining amount of the loan in any month is called the *unpaid principal balance* or UPB.) Because the balance is declining, the amount of interest charged to the borrower is also reduced over time; since the payment is fixed, the portion of the payment allocated to principal therefore grows. By month 60, for example, the $1,013 payment consists of $685 of interest and $328 of principal, and by month 176 the principal and interest components are both roughly $507. Figure 1.1 shows how this works over the life of the loan. (Note that for an ARM, the payment is recalculated every time the rate resets using the loan’s UPB and remaining term.)

Other amortization schemes can be utilized, although their use varies depending on acceptance by both market participants and regulators. The most common variety is an “interest-only” loan, for which the initial payment is calculated to consist solely of the interest due on the loan; at some point in the future, the payment increases (i.e., the loan “recasts”) to amortize the loan over the remaining (shorter) term. A more extreme variant is the “negative amortization” loan, which sets the initial payment at a level below the amount necessary to cover the interest due on the loan, with the difference added to the unpaid balance until the loan recasts.[3] A small number of loans are also structured to force the payment of the remaining principal at a designated point in the future. Such *balloon* loans have a payment calculated over a 30-year term, but the loan is fully paid down by the balloon payment after either five or seven years.

Prepayments

Also, as noted above, mortgage loans can be prepaid under a number of circumstances. Since almost all mortgages have “due-on-sale” clauses, the loan’s remaining balance is

[2] Mortgage payments are easily calculated in an Excel spreadsheet using the “PMT” function, and all financial calculators have a function that calculates a loan’s payment.

[3] Due to both the complexity of the loans and numerous problems associated with the product, issuance of negative amortization loans at this writing is negligible.

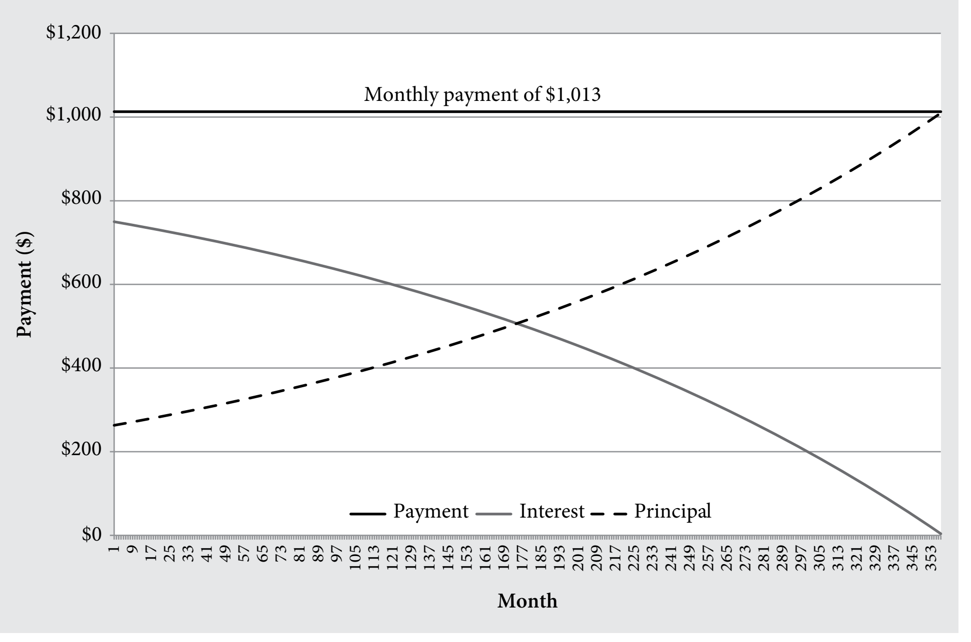

FIGURE 1.1 Monthly payment along with principal and interest allocation for 30-year 4.5% fully amortizing mortgage

prepaid when the underlying property is sold or otherwise liquidated (e.g., is destroyed and subject to an insurance claim). Such prepayments are broadly classified as *housing turnover*. *Refinancings* are said to occur when the existing loan is replaced with a new one, without any change in the property's status. Refinancings (or "refis") can be taken either for the current outstanding amount of the loan (called a *rate and term* refinancing), or for a larger balance (a *cash-out* refi) that allows the borrower to monetize some of the property's equity. Partial prepayments (or *curtailments*) occur when the borrower makes a payment larger than the minimum payment specified in the note; they are used by borrowers to pay off their loan faster than specified over the original term.

The above actions are classified as *voluntary prepayments*, since they take place at the discretion of the borrower. *Involuntary prepayments* take place when borrowers go into default on their loans. After a default occurs, the note holder ultimately receives at least some of the loan's principal, although both the amount and timing of the return of principal depend on a variety of factors. (For example, loans in agency pools are typically bought out of the pool once they are 90 days or more delinquent, returning the full amount of unpaid principal to the investors.)

Refinancings are the form of prepayment that most significantly influences the returns and risks of mortgages and mortgage-backed securities. Since the primary driver of refinancing activity is the level of mortgage rates, mortgage prepayments are commonly viewed as a form of interest rate option exercisable at the discretion of the borrower. However, there are important differences between prepayments on mortgages (and, by extension, the MBS into which they are pooled) and those of other forms of callable debt, such as corporate bonds. A corporate bond issue is entirely controlled by the corporation's treasurer, who makes a single and (hopefully) rational decision to call a particular bond depending on the level of rates and the costs involved with exercising the call (and, if necessary, issuing new debt in its place). An MBS pool, by contrast, may be backed by hundreds or thousands of loans, with each homeowner making refinancing decisions based on their individual financial circumstances and sophistication. Some borrowers will be highly efficient in exercising their prepayment options, while others will treat the option inefficiently (i.e., either prepaying loans with below-market rates or not refinancing high-rate loans) for a variety of reasons. As a result, analysts study and project the prepayment rates or "speeds" of individual securities and classes of MBS.

As with any form of debt, early retirement of the obligation impacts both the return and risk profile of the product for investors. For example, faster prepayment speeds reduce the yields and returns of MBS trading at a premium to par value, since the above-market interest rate offered by the securities will be available for a shorter period of time and the bondholder must reinvest the principal returned at lower interest rates. (The opposite also occurs: fast prepayments on discount securities improve their returns.) Changing prepayment speeds also impact the interest rate exposure associated with MBS. Since the interest rate risk (or *duration*) of any bond instrument is closely associated with the length of time for which the holder will receive cash flows, faster prepayments reduce a bond's exposure, while slower speeds increase the associated risk. This phenomenon increases the complexity of hedging a portfolio of mortgages or MBS, especially for investors tasked with outperforming an index or benchmark. The impact of prepayments on both the returns and risks of MBS forces investors to devote considerable time and resources to evaluating and projecting prepayment speeds.

Mortgage-Backed Securities

The market for MBS evolved to create a broader and more efficient source of funds dedicated to financing residential real estate. Before the development of the MBS market, mortgage lending was highly fragmented, consisting primarily of banks and depositories lending out their own funds (sourced mainly through consumer deposits) and holding the resulting loans as assets on their balance sheets. While this economic model worked reasonably well, it had a number of weaknesses. Since mortgage lending was a disjointed and fragmented industry, lenders were vulnerable to periodic shortages of funds in their local markets. When these shortages occurred, entire communities suffered the effects of a lack of available financing for home purchases. In addition, institutions holding 30-year fixed-rate mortgages in their portfolios funded with short-term borrowings have a structural yield curve exposure; their profits increase as funding costs drop and suffer when short interest rates rise. The investor community also looked covetously at the enormous pool of high-yielding unsecuritized assets held by banks and sought efficient ways to participate in the mortgage sector.

The MBS market evolved to better meet the needs of a number of constituencies.

- By creating a national mortgage market, borrowers benefitted from the consistent availability of mortgage funds.
- The broadening of the investor base served to push down mortgage rates vis-à-vis those of other instruments such as US Treasuries and corporate bonds.
- Financial institutions gained greater flexibility for their mortgage lending operations; they could originate mortgage loans and either hold them as assets or sell them into the capital markets and use the proceeds to fund new originations. The latter led to the growth of the mortgage banker, a new type of financial institution whose business model is built around intermediating between mortgage borrowers and the capital markets.
- Finally, investors were able to access an entirely new class of assets with a broad variety of attributes and risk/reward profiles that could be more closely aligned to their objectives and tolerances.

The last point merits special attention. An important factor in the growth of the MBS market was the ability of financial institutions to restructure mortgage cash flows and market the resulting securities to different investor clienteles with varying investment criteria. To appreciate this "clientele effect," consider the investment styles of a few different types of fixed-income investors. Banks, for example, often invest surplus funds that cannot be profitably lent to businesses or consumers in bonds, and have a very low tolerance for risk. By contrast, life insurance companies and pension funds have long-dated obligations, and typically buy bonds to fund these projected cash outflows. Hedge funds in turn seek to earn very high rates of return on their assets, and typically look to take on riskier investments using leverage. As we will discuss later, the nature of mortgage cash flows allows dealers to redistribute their principal and interest cash flows to create structured securities that are better tailored to meet the needs of particular investor market segments than generic MBS pools. The trade-offs for investors buying such structured securities, however, include accepting reduced liquidity and a heightened degree of complexity and opacity.

MBS Pools

The basic unit of all MBS is the *pool*. A pool is an aggregation of individual mortgage loans that have similar attributes and are grouped together within some form of a legal entity (e.g., a trust). The concept of pooling is straightforward. While all mortgages are unique instruments, aggregating significant numbers of them together creates an asset that will exhibit credit and prepayment performance reflecting the average composition of the underlying loans. Although "pooling" generally references the creation of agency MBS, it is useful to view all MBS as being comprised of pools. (Pools are also referenced as *passthroughs*, since they "pass through" principal and interest payments to the bondholders.)

While the rules governing how the pools are constructed vary by product, all pools have a few basic metrics with which they can be evaluated.

- Weighted average coupon (WAC): The average note rate of the underlying loans weighted by their UBPs. (Technically "WAC" is a misnomer, as a pool's "coupon rate" is the rate paid to the investors.)
- Weighted average maturity (WAM): The weighted average of the final maturities of the loans in the pool, quoted in months.
- Weighted average loan age (WALA): The weighted average age of the loans in the pool, again quoted in months.

A pool's WAC is an important piece of information, since it indicates how incentivized the pool's underlying borrowers might be to refinance their loans. The age (or *seasoning*) of the pool, as indicated by the WAM and WALA, is important for a variety of reasons; in addition to being necessary to modeling the pool's cash flows, the age is also an indicator of the borrowers' expected prepayment behavior.[4]

Within the agency MBS sector, both fixed- and adjustable-rate pooling practices require that a minimum amount of all loans' note rates (typically 25 basis points) must be retained as *required* (or *base*) *servicing*. In addition, a *guaranty fee* (essentially an insurance premium) must be paid to the agency in question from the note rate of each loan (or, as discussed later, monetized as an upfront payment). For fixed-rate pools, the coupon rate of all the loans in the pool must be less than or equal to the note rate less the base servicing (sometimes called the *net note rate*), and the pools have a targeted coupon rate (typically stratified in 50 basis point increments, i.e., 3.5%, 4%, etc.). By contrast, the loans in an ARM pool can have note rates either above or below the pool's coupon, which is calculated as a weighted average of the net note rate less the guaranty fee of all the loans in the pool. Rather than targeting an "even" coupon rate, therefore, the coupon rate of ARM pools falls out from the loans in the pool (and typically is quoted to three decimal places).

[4] Normally, the WAM of a brand new 30-year pool will be 360 months, and the pool's age in theory should be 360 minus the WAM. However, since maturities shorter than 30 years can be included in a 30-year pool, the WAM at origination may be shorter than 360 months, making the WALA a better indicator of a pool's age.

Structured Securities

As noted earlier, MBS cash flows can be redistributed to create a variety of bonds with different characteristics. This is accomplished by placing either existing MBS pools (with a single coupon) or whole loans in a trust-like vehicle and then creating a set of rules that redirect principal and interest to different *tranches* (which is a French term meaning "slices"). A host of bond metrics can be targeted, including dollar price, weighted average life, and final maturity; bonds can also be created with different exposures to prepayments, as well as interest accrual features that serve to minimize reinvestment risk. The issuing dealer will market the new tranches to different clienteles. For example, they might sell a short tranche to a bank and the resulting longer bond to a pension fund. These structured deals, generically referenced as *CMOs*,[5] can be quite complex; the ability to redirect both interest and principal cash flows allows for the creation of a host of different bonds with a wide variety of features and characteristics.

Agency CMOs

Agency CMOs are transactions backed by agency MBS pools purchased in the secondary MBS markets. The transactions serve as arbitrages; dealers structuring and issuing agency deals seek to profit from the transaction by buying the pools in the secondary market and selling the resulting bonds at a higher cumulative value, capitalizing on the various clientele preferences.

An agency transaction is a closed universe where the sum of all the tranches' principal and interest cash flows must equal the cash flows generated by the underlying passthroughs ("the collateral"). By implication, every type of tranche that can be structured throws off its counterpart tranche. As an example, creating a bond with a weighted average life shorter than that of the collateral (using a technique called *sequential tranching*) creates another bond with a longer average life. A bond designed with protection from changing prepayment rates in turn creates another bond or bonds with heightened prepayment sensitivity. As a result, it is most useful to think of structuring combinations rather than simply consider a single tranche or tranche type in isolation. Once created, tranches can be further restructured ("tranched") to meet even more exact specifications. (In the terminology of structuring, the original tranche or asset being structured is the "parent" and the resulting tranches are the "children." The parent can also be the original collateral pool of MBS passthroughs.) Whether a certain type of tranche can be created is a function of the attributes of the parent, the types and specifications of the

[5] Originally, the prevailing tax laws forced structured securities to be created as Collateralized Mortgage Obligations (CMOs), which meant that the tranches created were technically bonds collateralized by the assets in the trust, rather than representing an ownership interest in the cash flows. The Tax Reform Act of 1986 introduced the Real Estate Mortgage Investment Conduit (REMIC), which allowed for full ownership of the cash flows without creating a tax liability. However, the products are still referred to as CMOs using the old terminology.

children being created, and other exogenous factors (e.g., a minimum tranche size). Creating different tranches from MBS passthrough pools capitalizes on market inefficiencies in the pricing of the different tranches to create arbitrage profits for the issuing dealer. Agency CMOs also do not require additional credit enhancement; the issuance of the transaction under an agency name (or "shelf") along with the agency credit support for the collateral is sufficient to qualify as a high-quality asset for most investors.

As the name implies, sequential tranching directs the collateral's principal cash flows sequentially to a series of child bonds, creating tranches with different average lives and durations. In addition to this simple tranching technique, there are a wide variety of tranche types and structuring combinations that can be created. The three most common derivations are:

- PAC/Support structures: *PACs* (short for "planned amortization classes") are created by assigning a schedule to one of the child bonds. Monthly principal is paid to this child (i.e., the PAC) until the schedule is met; the remaining principal is paid to the *support* bonds. As a result, the PAC receives relatively stable principal payments, giving it unchanged average lives and durations over a (limited) range of prepayment speeds. The support tranche(s) in turn has greater average life and duration variability than the parent at different prepayment speeds.
- Accrual/Accretion-Directed structures: A tranche that doesn't receive principal payments immediately (or, in the parlance, is "locked out") can be converted to an *accrual* (or *Z*) tranche by having its interest payments directed to another tranche, called an *accretion-directed* (AD) tranche. AD tranches have both very stable average life profiles and short legal final maturities. The Z tranche's face value accretes over time until the AD bond matures, by which time the Z's UPB is significantly larger than at origination; at that time, the Z pays principal and interest like a regular tranche.
- Floater/Inverse Floater combinations: A floating-rate bond (or *floater*) can be created from fixed-rate collateral by giving a child tranche an adjustable interest rate calculated by adding a spread to a money-market rate or index. The remaining interest is directed to an *inverse floater*, so referenced because its coupon moves inversely with changes to the referenced rate.

A deal's arbitrage profit comes from the fact that the various tranches trade at different prices than the collateral. In a PAC/support combination, for example, the PAC or PACs trade to relatively high dollar prices due to their greater stability, while the supports trade at lower prices due to their greater cash flow volatility. A profit is realized if the improved execution for the PAC more than offsets the concession needed to sell the support tranche(s).

Non-Agency (Private-Label) CMOs

Private-label CMOs are deals created and marketed by entities other than the agencies, such as dealers or originators. Because the agencies don't provide any form of credit support, *credit enhancement* must be utilized in order to create tranches that have a triple-A rating from one or more rating agencies. Credit enhancement can take the form of external credit support (such as insurance policies) or internal support built into the structure itself (i.e., credit tranching). The most common form of internal credit support is *subordination*. As the name suggests, subordinate tranches are lower in priority to the senior tranches, which are typically rated triple-A at issuance and comprise the bulk of the deal's original UPB; the subordinates (or "subs") receive principal and interest only after the senior bonds receive their expected allocation of cash flows, and are written off before any of the senior bonds absorb losses.

Securitizations must be executed as private-label transactions when the underlying loan collateral is not eligible for agency MBS pooling, either because the balances are too large or the credit profile of the loans do not meet the prevailing agency underwriting standards. However, private-label deals are not issued as an arbitrage; rather, the transactions are used to distribute loans directly into the capital markets. As the deals are backed by loans rather than by pools (as in the case of agency CMO deals), they are also sometimes called "whole loan" deals.

Private-label transactions can be issued with one senior tranche whose cash flows mimic those of a passthrough. Alternatively, the senior tranches can be tranched using many of the same or similar techniques as those utilized for agency CMOs. Whether or not the senior tranches are tranched depends on market conditions, reflecting the issuer's desire to maximize the proceeds received for the sale of the underlying loans.

MBS Markets

MBS trading takes place in a complex and multi-tiered market. The structure and practices of the market reflect the nature of both the securities being traded and the industry that creates and distributes them. The following section describes trading practices for agency MBS pools and does not apply to either structured agency MBS or non-agency transactions.

The TBA Market

The bulk of MBS passthrough trading takes place in the "To Be Announced" (TBA) market, which is a market for forward commitments to buy and sell standardized MBS. The market gets its name from the fact that the identity of the actual securities changing hands is not known until just before settlement. The TBA market facilitates trading in fixed-rate MBS[6] created under the auspices of the three agencies, with coupons in even 50 basis point increments (i.e., coupons of 4.0%, 4.5%, etc.) for multiple consecutive settlement months. Monthly settlements take place on days designated by the industry

[6] Despite a number of initiatives, there is no TBA market for ARMs.

trade association. (While trades can be settled on other days, most trades are executed for "good-day" settlement.)

The actual pools used to satisfy open TBA commitments are created prior to settlement and delivered against the open TBA commitment at settlement. The settlement process is known as *allocations*. Forty-eight hours prior to settlement, the seller provides the counterparty with a list of the pools that will be delivered against the TBA commitment. The pools must meet the trade association's specifications for *good delivery*; in addition to being for the correct product and coupon, only three pools per million dollar face value can be delivered, and the face value must be within a tolerance (i.e., a *variance*) of 0.01% or $100 per million. There are also rules that stipulate the attributes of the mortgages that can be placed in a pool eligible for delivery into a TBA (i.e., a "deliverable pool"). Certain loans (such as loans with LTVs greater than 105%) cannot be included in deliverable pools and are not considered "good delivery" against TBAs. Non-deliverable pools, as well as deliverable pools that might be valued at a premium over TBAs, are traded as "specified pools" as described in the next section.

The fact that the TBA market allows trading to take place for multiple months' settlement facilitates transactions known as *dollar rolls*. Dollar rolls (or simply "rolls") are trades where TBAs are bought (sold) for a particular month's settlement and simultaneously sold (bought) for a later settlement. Note that the economic value of any security or asset changes the further into the future the transaction's settlement is pushed, since the investor is forgoing the economic benefits and costs of actually owning the security.[7] Bids and offers for dollar rolls are quoted at a spread or *drop* (since the spread is typically negative for instruments generating cash flows) between the prices of the settlement months. The market's terminology means that the buyer of a dollar roll is buying TBAs to settle in the earlier (or *front*) month and simultaneously selling the later (*back*) month; the seller of a roll is doing the opposite.

The existence of the dollar roll market offers a substantial convenience to traders and serves a number of purposes. For example, an originator may have hedged its overall pipeline risk accurately but may not close enough loans to deliver into its open TBA short position for a particular month; the originator would then buy the roll and push its commitments further into the future. Alternatively, an investor may sell the roll in order to finance a position in MBS; when the drop is greater than the roll's economic value, the roll is considered "special" and the investor can finance a position in MBS at a below-market cost of funds.

As an illustration of the TBA market's structure, Figure 1.2 contains a Thomson Reuters Eikon screen for Fannie Mae TBA prices as quoted electronically by dealers over the Tradeweb platform. It shows markets for a range of coupons for settlement months December through February, along with markets for the December/January and January/February rolls. The screen shows the daily change for the TBAs along with bid and offer prices for both TBAs and the rolls.

[7] Bond buyers are not entitled to principal and interest payments until their purchases settle, but also do not need to finance the position.

TRADEWEB 30-YR FNMA

Cpn	Month	ΔPrice(3pm)	ΔPrice(4:45pm)	Bid	Ask	Time
2.50	Dec	+0*21	0*21	96*26	97*08	11:07
2.50	Jan	+0*21	0*21	96*19½	97*01½	11:07
2.50	Feb	+0*21	0*21	96*14	96*28	11:07
2.50	Dec/Jan	+0*00½	0*00½	0*06½	0*06¾	10:41
2.50	Jan/Feb			0*05½	0*05¾	8:03
3.00	Dec	+0*10½	0*09	100*13½	100*14½	11:35
3.00	Jan	+0*09½	0*08½	100*05½	100*06½	11:34
3.00	Feb	+0*09½	0*08½	99*31	100	11:34
3.00	Dec/Jan	+0*00⅜	0*00¼	0*07⅝	0*07¾	10:22
3.00	Jan/Feb	+0*00⅛		0*06⅜	0*06½	8:14
3.50	Dec	+0*09	0*08	103*19½	103*20½	11:36
3.50	Jan	+0*09	0*08	103*11½	103*12½	11:36
3.50	Feb	+0*09	0*08	103*04½	103*05½	11:36
3.50	Dec/Jan			0*07⅞	0*08	10:19
3.50	Jan/Feb	+0*00⅛	0*00⅛	0*07	0*07⅛	10:49
4.00	Dec	+0*07½	0*06	106*05½	106*06	11:35
4.00	Jan	+0*07	0*06	105*30	105*31	11:35
4.00	Feb	+0*07	0*05½	105*23½	105*24½	11:35
4.00	Dec/Jan	+0*00⅜	0*00¼	0*07¼	0*07⅜	10:08
4.00	Jan/Feb	+0*00¼	0*00¼	0*06⅜	0*06½	9:15

FIGURE 1.2 Sample market quotation screen for Fannie Mae TBAs

Source: Thomson Reuters Eikon and Tradeweb. Used with permission.

The TBA market developed in its current form because it reflects the operations and practices of the primary mortgage market, specifically with respect to managing a pipeline of mortgage applications. It allows originators to lock the note rates on loan applications and sell them in the form of forward commitments for different months, depending on the terms of their rate locks. It is also consistent with the reality that pools cannot be created until the loans themselves are funded, which typically occurs after the loans' rates are locked and need to be hedged.

Specified Pool Trading

Traders also buy and sell MBS pools in a process called *specified pool trading*. Specified pools are traded outside of the TBA framework for a number of reasons. As described in the previous section, pools of non-deliverable loans cannot be delivered into TBA transactions and must trade separately from the TBA market. In addition, some pools are viewed as having advantageous characteristics that give them slower and/or more stable prepayment characteristics, and traders attempt to monetize their incremental value by marketing them separately from TBAs. Briefly, there are a number of loan characteristics that tend to result in slower prepayments and/or reduced responsiveness to refinancing incentives. The best-known attributes are smaller loan balances, higher LTVs, and impaired borrower credit. Small loans tend to be less responsive to refinancing incentives, as the payment savings are diminished for loans with smaller balances. (Since refinancings are accompanied by substantial fixed costs, greater savings are needed to justify the transaction.) Loans with weaker credit (such as low FICO scores) have long tended to pay relatively slowly, since these borrowers have difficulty in obtaining new loans. (Their prepayment advantage is even more pronounced in a tight credit environment.) A similar phenomenon suppresses prepayments on high LTV loans, although their prepayment performance is strongly influenced by rates of home price appreciation.

Specified pool trading is more than 30 years old, and originally began as investors evaluated the pools being delivered into TBA transactions to see if either attractive attributes or a favorable prepayment history could be identified. Pools with perceived incremental value were then segregated and marketed directly to investors. The development of a market for new-origination specified pools or "customized MBS", in which originators sell prepayment-advantaged loans separately from their generic production, began in the late 1990s, as analysts identified loan characteristics that resulted in consistently improved prepayment behavior. (By "improved," investors generally look for prepayment speeds that are either slower than average or less sensitive to changes in mortgage rates.) Most specified pool trades are priced using TBAs as a benchmark; the pools either trade to a pay-up to TBAs (for favorable attributes) or a concession (for non-deliverable pools). Note that a deliverable pool will never trade behind TBAs even if it has unfavorable attributes, since it can simply be delivered into a TBA transaction as the "worst-case delivery."

Interactions between the Mortgage and MBS Markets

An interesting aspect of mortgages and MBS is the degree of interdependence between the two sectors, as actions in one sector impact the other in both direct and subtle fashions. Changes in capital market pricing often influence consumer and lender behavior, which often in turn reverberate into MBS pricing and investor behavior. In this final section, we will address a few of the ways that the mortgage and MBS markets interact with each other.

Generating Consumer Mortgage Rates

The process of generating consumer mortgage rates is a complex interplay between market prices for MBS, servicing valuations, the cost of credit support, and the operating costs and profit margins built into each loan. Before continuing, it is important to note that lenders do not actually calculate and quote rates; rather, they quote the amount of fees or rebates paid by/to the borrower at a range of note rate levels for a given period of time. The resulting pricing is shown in the form of a matrix, a hypothetical version of which is shown in Table 1.1. (Positive points are paid by the borrower to the lender; negative points are rebated to the borrower and/or used to offset the costs associated with the loan.)

There are two steps necessary to calculate the points at each note rate strata:

1. determine the selling strategy that provides optimal execution for a loan;
2. calculate the points based on market prices and values.

Determining Optimal Execution

This discussion of how optimal execution (colloquially referred to as *best-ex*) for a loan is calculated assumes that the lender in question will package and sell their (fixed-rate agency) loans as MBS pools, with the question being the coupon into which the loans will be pooled. In practice, however, the methods used to sell loans vary widely, depending on the size and sophistication of the lender. Some lenders have many best execution options, while others are limited to the most basic secondary market agreements. Absent other considerations, the originator will allocate closed loans into the MBS coupon that provides the greatest proceeds. The major variables are (1) the market prices of the different coupons; (2) the value that the originator places on "excess servicing" (i.e., servicing in excess of the 25 basis points of required servicing; (3) the amount of

Table 1.1 Hypothetical rate/points matrix

		Lock Expiration		
		30 Days	*45 Days*	*60 Days*
	4.250%	−1.125	−1.000	−0.875
Note	4.125%	−0.500	−0.375	−0.250
Rate	4.000%	0.000	0.125	0.250
	3.875%	0.500	0.625	0.750

the guaranty fee; and (4) the price at which the GSE will allow the originator to monetize (or "buy down") the guaranty fee.

Before proceeding, it is important to remember the following:

- lenders almost always create coupons in 50 basis point increments, mirroring the conventions of the TBA market;
- the servicer (often the originator) must retain 25 basis points of the loan's note rate as a base servicing fee; and
- a guaranty fee must be paid to the agency in question. The g-fee is either directed to the agency as a fixed rate (quoted in basis points) from the note rate, or paid to the GSE in question as a one-time payment (called "buying down" the g-fee).

As illustrated in Figure 1.3, lenders generally weigh execution into two pooling coupons. The example shows the two primary options for how a loan with a 4.25% note rate can be pooled (or "slotted") into pools for one particular GSE. Because of the required 25 basis point servicing, the highest possible pooling option is as a 4% pool, while the next lowest coupon rate is 3.5%. Pooling into the higher and lower potential coupons is referenced as "pooling up" and "pooling down," respectively. (In theory, it could also be slotted into a 3% pool, but pooling down to a coupon this low rarely offers optimal execution.) Assume a 40 basis point g-fee, slotting the loan into a 3.5% pool would require that a 10 basis point strip of excess servicing is held (or sold) by the originator, while pooling into a 4% pool means that the entire g-fee must be bought down and paid to the GSE when the pool is created.

The economics of the best-ex calculation for a 4.25% loan are shown in Table 1.2. In the hypothetical example, both the value of servicing and the buydown fee are calculated by applying *multiples* to the interest strip in question. The multiples for servicing

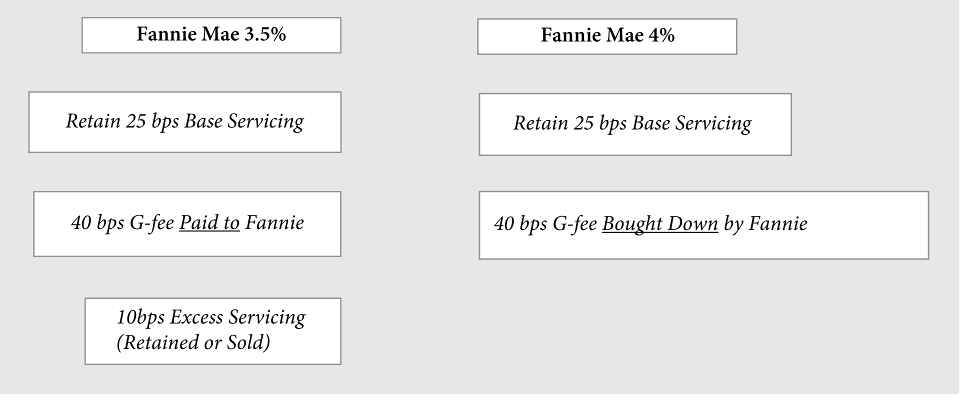

FIGURE 1.3 Different pooling coupons options for a 4.25% 30-year loan (assumes g-fee of 40 basis points)

Table 1.2 Best-execution analysis for a 4.25% 30-year loan

	FNMA 3.5%	FNMA 4%
25 bp Base Servicing (Priced at 4x Multiple)	1.00	1.00
Price of Passthrough	102.75	105.00
Value of Excess Servicing (10 bps. Priced at 4x Multiple)	0.40	
G-Fee Buydown (40 bps at 5x Multiple)		–2.00
Costs and Profit Margin	–2.00	–2.00
Net Proceeds	**102.15**	**102.00**

represent where the lender estimates that the servicing asset either can be sold or should be valued on the lender's books; the g-fee buydown multiples (or "mults") are quoted by the GSE in question.[8] In the example, pooling into a Fannie 3.5% coupon represents better execution by 0.15 points (i.e., 15 basis points), using the assumed prices and multiples. Note that the decision would change under the following conditions:

- the price of Fannie 4%s relative to 3.5%s improved by more than 15 basis points;
- the value of excess servicing improves;
- the g-fee buydown multiple is reduced; or
- the g-fee is reduced by more than 15 basis points.

Generating a Rate Sheet

Once best-ex is calculated for each applicable note rate strata, the pricing matrix can be generated. The points associated with each note rate strata are generated by calculating the all-in value of the loan given its best execution and subtracting it from par value (i.e., 100). As shown in Table 1.3, the all-in value takes into account all revenues, values, and costs associated with a loan. The revenues and values include the security proceeds and the values of base and excess servicing; the costs include any g-fee buydown, the costs associated with making the loan, and the expected profit margin. In the hypothetical example in the table, loans with note rates of 4.0% and 3.875% are associated with a rebate, while the 3.75% note rate requires a quarter-point payment to the lender.

MBS Supply and Coupon Swaps

A time-honored trading strategy is to buy and sell different MBS coupons based on their perceived relative value. However, the relationship between the prices of different cou-

[8] Multiples are used to calculate the value of cash flows either comprised entirely of interest or that mimic interest payments. The value of the cash flow is simply the multiple times the number of basis points the cash flow represents. For example, 15 basis points valued at a 4× multiple represents 0.60 in price.

Table 1.3 Pricing of loans with different note rates

Note Rate	4.25%	4.125%	4.00%
Fannie 3.5% Price	*101.5*	*101.5*	*101.5*
Base Servicing			
Amount Retained (Basis Points)	25	25	25
Value (4x Mult)	*1.00*	*1.00*	*1.00*
Guaranty Fee			
Amount Bought Down (bps)	0	2.5	15
Value (5x Mult)	*0*	*−0.125*	*−0.75*
Excess Servicing	10	0	0
Value (4x Mult)	*0.40*	*0.00*	*0.00*
Costs and Profit Margin	−2.00	−2.00	−2.00
Total Proceeds	100.90	100.38	99.75
Points Paid To/Received From Lender	−0.900	−0.375	0.250
Rounded Points (Nearest Eighth)	***−0.875***	***−0.375***	***0.25***

Assumptions
* All loans best-ex into Fannie 3.5%s
* 40 bp g-fee

pons is subject to a feedback loop of sorts between market levels and originator production. In the earlier discussion of best execution, we noted that loans with given note rates can either be pooled into higher or lower coupons (i.e., "pooling up" versus "pooling down"). Referring again to the example in Table 1.3, the best-ex for a 4.25% loan would change from Fannie 3.5%s to Fannie 4%s if the coupons' price spread (or the "coupon swap") widened by more than 15 basis points. If this happens for large numbers of loans with current note rates, originators' production would shift from Fannie Mae 3.5% pools to Fannie 4%s, which in turn would impact the makeup of MBS issuance. To some extent, supply shifts due to best-ex changes are self-correcting; in the example in Table 1.3, a relative pickup in the supply of Fannie 4%s would put pressure on the coupon swap and possibly push best execution for that note rate back into the 3.5% coupon. However, persistent changes in the relationships between coupons and the resulting production shifts can impact a variety of factors, including originators' hedging decisions, agency CMO issuance, and dollar roll prices.

Borrower Refinancing Incentives and MBS Prepayments

While prepayments are an option controlled by the borrower, actions by the "mortgage industry" (which in this case encompasses both lenders and servicers) can profoundly impact both realized prepayment speeds and investors' prepayment expectations. For example, loan brokers tend to be quite aggressive in contacting previous clients and offering refinancing opportunities when rates drop, since their revenues are dependent on generating new loan originations. As a result, investors impute faster prepayment speeds for securities containing a large share of loans originated by brokers and other third-party lenders. Servicers also vary in their willingness to solicit refinancings from borrowers whose loans they are servicing; as a result, specified pool investors will therefore take servicers' historical prepayment performance into account in valuing specified pools and other securities.

Moreover, changes in capital markets pricing strongly influence borrowers' perceived refinancing incentives and thus prepayment speeds. When the news media reports on changes in "rates," they are often referencing intermediate Treasury yields, which decline as bond prices rise and vice versa. As demonstrated previously, however, mortgage rates are determined by MBS prices, which may or may not change with shifts in the Treasury market. For example, it's quite common for MBS prices to rise less than Treasury prices, adjusted for duration, due to investor expectations for faster prepayments. In this case, a decline in Treasury yields might not cause a commensurate improvement in mortgage pricing, which in turn would limit the refinancing response of borrowers and thus any pickup in prepayment speeds.

Key Points

- Residential mortgages issued in the United States comprise one of the largest classes of assets in the world.
- All mortgage loans represent collateralized borrowings against real property, and have a variety of attributes that include a note rate, a term, and an amortization scheme.
- Mortgages can be classified by a number of characteristics, including the presence of government guarantees along with balance and regulatory classifications.
- The credit approval or underwriting process involves both gauging an applicant's ability and willingness to make timely payments on their loan, as well as judging whether the value of the property is sufficient to satisfy the debt under a variety of adverse circumstances if the borrower defaults on the obligation.
- Metrics used to measure a borrower's creditworthiness include credit scores and debt-to-income ratios, while the adequacy of the underlying property's value is measured by various loan-to-value ratios.
- Beginning with the New Deal programs of the 1930s, the federal government actively supports the US mortgage market through a variety of programs and entities designed to provide credit support for certain types of loans, as well as improve the liquidity of different mortgage products.
- There are a variety of institutions that originate mortgage loans. They can be broadly classified as either mortgage bankers that originate loans to sell into the capital markets, or depositories that have the option of holding some or all of their loan production as assets on their balance sheets.
- Mortgages can generally be prepaid by the borrowers at their option.
- Prepayments can take place due to the sale of the underlying properties or the refinancing of the mortgage loans.

- Prepayment rates or "speeds" impact the returns received by investors that hold either the loans or securities backed by such loans.
- The market for mortgage-backed securities evolved to facilitate lenders' ability to liquefy their mortgage production and recycle the resulting proceeds into new loans.
- The basic unit of all MBS is the pool.
- Most MBS trading takes place in a forward (TBA) market where the pools to be delivered are not known until just prior to settlement.
- Activity in the MBS market is facilitated by the presence of entities backed by the US government. These entities consist of both a government agency (Ginnie Mae, a unit of HUD) and two government-sponsored enterprises (Fannie Mae and Freddie Mac), which were chartered as hybrid public/private corporations but, at this writing, are controlled by the federal government.
- The three "agencies," as they are referenced, facilitate the creation of pools that are either delivered into open TBA trades or can be traded separately as "specified pools."
- While there are limits to the attributes of loans that the agencies allow in their pools, a very large share of loans originated in the current market are securitized in agency pools.
- The MBS market evolved to facilitate the creation of "structured MBS" that more closely meet the specifications of different communities of fixed-income investors.
- Such structured MBS can be issued by either one of the agencies or by a corporate issuer; the former are backed by agency pools, while the latter are collateralized by unsecuritized loans.
- MBS structures can allow for the redistribution of principal and/or interest cash flows, as well as credit risk and exposure to writedowns (in non-agency transactions).
- The mortgage and MBS markets have developed a close linkage. This is readily apparent in the primary mortgage market; the process that lenders employ to generate consumer loan pricing (in the form of rate sheets) uses MBS market prices both to determine the execution option that maximizes sale proceeds and calculate the pricing published by lenders on their rate sheets.

CHAPTER 2

UNDERSTANDING THE PROSPECTUS AND PROSPECTUS SUPPLEMENT FOR MORTGAGE-BACKED SECURITIES

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After reading this chapter you will understand:

- how the financial crisis affected regulatory reporting requirements and disclosure practices for mortgage-backed securities;
- the most recent regulatory updates to the Securities Act disclosure framework and the new reporting and disclosure requirements under Regulation AB II;
- the differences in reporting and disclosure practices between agency and private-label mortgage-backed securities;
- the typical disclosures that can be found in a private-label prospectus and prospectus supplement, and the benefits and limitations of the disclosures;
- the typical disclosures that can be found in an agency prospectus and prospectus supplement, and the benefits and limitations of the disclosures;
- that disclosure standards and offering procedures for mortgage-backed securities continue to evolve based on investor needs and demands.

This chapter will discuss an agency and a private-label mortgage-backed securities (MBS) issuance to highlight the current differences in investor disclosures. In addition, given the substantial changes in rulemaking, we will discuss the current state (pre Regulation AB II) of the prospectus and prospectus supplement for MBS. We have highlighted the key areas of the prospectus and prospectus supplement that are affected by the provisions of Regulation AB II (future state).

We will also describe the types of information that are available to investors in a typical prospectus[1] and prospectus supplement, and the benefits and limitations of the reported data.

The Mortgage Industry

US mortgage-backed securities (MBS) have experienced significant change since the first MBS was issued in 1968.[2] Over the years, additional types of mortgage loans and different bond structures have emerged in response to investor appetite for risk and returns. Similarly, the offering documents of MBS have evolved to satisfy the demands of investors for more and varied information so that informed buy and sell decisions may be made.

Currently, the US mortgage-backed securities market is comprised of two main sectors, agency or government issuance[3] and non-government issuance (also called private-label because it is issued by private institutions[4]).

The US MBS market is extensive with approximately $13.4 trillion[5] of total outstanding US mortgage debt as of the fourth quarter 2014 and $7.58 trillion of MBS outstanding ($6 trillion of agency and $1.58 trillion of private-label MBS outstanding).[6]

Since the financial crisis, the US MBS market has been dominated by government-sponsored issuance. During 2014, new issuance of agency mortgage-backed securities totaled $1.2 trillion while private-label issuance totaled only $78.7 billion, of which less than 1% of private-label issuances were registered transactions and publicly issued. Most private-label issuances that are not registered securities are generally sold in the 144A market (initially to dealers, and then subsequently for resale by dealers in private transactions to "qualified institutional buyers" as such term is defined under the Securities

1 Documents substantially similar to a prospectus are referred to as an Offering Memorandum or Offering Circular. These documents are used for those offerings that are exempt from SEC registration.

2 Ginnie Mae guaranteed the first mortgage passthrough security of an approved lender in 1968, Freddie Mac issued its first mortgage passthrough in 1971 and the first collateralized mortgage obligation in 1983, Fannie Mae issued its first mortgage passthrough in 1981, and in 1977 Bank of America issued the first private-label passthrough securitization.

3 Agency mortgage-backed securities are issued by government-sponsored enterprises (GSEs), such as the Federal National Mortgage Association (Fannie Mae) and the Federal Home Loan Mortgage Corporation (Freddie Mac), and wholly owned federal government entities such as the Government National Mortgage Association (Ginnie Mae). Agency mortgage-backed securities are largely exempt from federal securities laws.

4 Private-label issuers typically include commercial banks, mortgage companies, investment banking firms, and other entities that acquire and package mortgage loans for resale as MBS.

5 <http://www.federalreserve.gov/econresdata/releases/mortoutstand/current.htm>.

6 US Research Quarterly, Fourth Quarter 2014, <http://www.sifma.org/research/item.aspx?id=8589953382>.

Act of 1933).[7] The key difference between agency and private-label is the data disclosed to understand the collateral pool, as most private-label MBS are not guaranteed by a GSE, the US government, or a private-sector entity.

Before the financial crisis, the vast majority of private-label MBS were registered transactions and issued publicly.[8] These registered transactions evolved over time and shaped the disclosures and level of granularity of data for private-label MBS issuances.

The registration, disclosure, and reporting requirements for publicly issued MBS are governed by the Securities Act of 1933 and the Exchange Act of 1934. The modern asset-backed securitization market did not exist at the time of the creation of these laws, and as a result, the process of MBS registration has been revised several times by Congress and the Securities and Exchange Commission (SEC) to better reflect the evolving needs of the asset-backed securities (ABS) market.

The latest revision occurred on September 24, 2014. The SEC published final regulations labelled "Regulation AB II"[9] that significantly revise the rules governing disclosure, reporting, registration, and the offering process for asset-backed securities. The 2014 amendments were designed to improve investor protections and promote more efficient asset-backed markets.[10]

Registered MBS must comply with:

- Regulation AB II (except for asset-level disclosures) beginning November 23, 2015, and
- asset-level disclosures beginning November 23, 2016.

Securities Act Registration Statements—The Disclosure Framework

The Securities Act of 1933 defines a prospectus as "…any prospectus, notice, circular, advertisement, letter, or communication, written or by radio or television, which offers any security for sale or confirms the sale of any security…."[11]

The purpose of the prospectus is to disclose key material facts about an MBS that an investor needs in order to make an informed purchase decision and generally contain:

[7] Rule 144A provides a safe harbor from the registration requirements of the Securities Act of 1933 provided that the resale of securities is to certain "qualified institutional buyers" or QIBs.

[8] <http://www.federalreserve.gov/BoardDocs/RptCongress/securitization/risk_d_links.html>.

[9] <http://www.sec.gov/rules/final/2014/33-9638.pdf>.

[10] See Asset-Backed Securities, Release No. 33-9117 (April 7, 2010) [75 FR 23328] (the "2010 ABS Proposal").

[11] 15 U.S.C. 77a et seq.

- a description of the offered securities and the assets backing those securities,
- the legal and structural framework of the trust,
- the associated parties to the transaction, and
- a disclosure of investment risks.

Currently, dealers are required to deliver a preliminary prospectus or "red herring" prior to delivery of a confirmation of sale. The prospectus is filed with the SEC using prescribed forms. Most MBS are filed using form S-3 (for repeat issuers), although some MBS/ABS securities are filed using form S-1.

In 1992, the SEC amended form S-3 to allow registration of investment grade ABSs on a delayed, or "shelf," basis. Form S-3 allows an issuer or sponsor to register ABS for future issuance(s) through one or more offerings that represent a "takedown" off the shelf registration statement.

Shelf registration on form S-3 has become the preferred method of registration for public offerings of MBSs. Offerings that do not meet the technical definition of "asset-backed security" are typically registered on form S-1.[12]

For offerings registered on a shelf basis on form S-3, the disclosure in the registration statement is typically presented through the use of two documents: the "base" or "core" prospectus and the prospectus supplement.

The base prospectus discloses the parameters and definitions or a menu of the different types of security that may be offered in the future, including the:

- types of assets that may be securitized,
- types of security structures that may be used,
- types of possible credit enhancements, and
- parties to the transaction.

The registration statement also contains one or more forms of a prospectus supplement, which outlines the format of deal-specific information that will be disclosed at the time of each future issuance, or "takedown." At the time of a takedown, a final prospectus supplement is prepared which describes the specific terms of the offered securities. The prospectus supplement and the base prospectus form the final prospectus which is filed with the SEC.

Regulation AB II revises the shelf registration and offering process for issuers of ABSs. The new rules are meant to provide investors with more granular data and more time to review such data so that an informed purchase decision may be made.

[12] Examples of mortgage-related securities that do not meet the form S-3 definition of asset-backed securities include "synthetic" securitizations. These trusts are designed to create exposure to a pool of assets that is not transferred into the trust. These synthetic transactions are generally structured through the use of derivatives such as a credit default swap or total return swap. The return on the ABS is primarily based on the performance of the asset pool only by reference through the credit derivative. Ownership of the assets does not transfer to the trust. For more information about synthetic securitizations, see Mark J. P. Anson, Frank J. Fabozzi, Moorad Choudhry, and Ren-Raw Chen, *Credit Derivatives: Instruments, Applications, and Pricing* (Hoboken, NJ: John Wiley & Sons, 2004).

Forms SF-1 and SF-3 will replace forms S-1 and S-3, respectively, starting no later than November 23, 2015, to distinguish ABS offerings in the marketplace.

Form SF-3 requires a single integrated prospectus for each offering of ABSs (combining the base prospectus and prospectus supplement) and requires that the preliminary prospectus be filed with the SEC at least three business days prior to the first sale.[13] Any material changes to the preliminary prospectus must be filed with the SEC at least 48 hours prior to the first sale.

Form SF-3 requires brokers and dealers to deliver a preliminary prospectus to the investor at least 48 hours prior to the investor receiving a confirmation of sale (removing the exemption under Exchange Act Rule 15c2-8(b) which is commonly used), and requires that final transaction documents be filed with the SEC when the final prospectus is filed.

Disclosures for Registered MBS Offerings

Investment-grade MBS offerings registered on form S-3 presented their principal disclosures in the base prospectus and prospectus supplement in lieu of incorporating such information by reference. Form S-3 instruction for ABS, as described in "Regulation AB,"[14] specified additional information that must be reported in the registration. Issuers determine which information is applicable and is material for disclosure for each offering.

Form SF-3 replaced form S-3 (effective November 23, 2015) and eliminated the investment-grade ratings requirement for shelf eligibility. The new form establishes new issuer and transaction eligibility requirements, including:

- a certification by the chief executive officer of the depositor regarding the disclosures in the prospectus and the structure of the securitization at the time of filing for each takedown;
- inclusion of certain provisions in the transaction documents regarding
    - asset representations reviewer and its compliance with certain representations and warranties of the assets made in the prospectus;
    - dispute resolution procedures for unresolved repurchase requests that are 180 days or more outstanding, using certain prescribed definitions and methodologies in calculating delinquencies; and

13 Current market practice for many registered securitizations is to issue a preliminary prospectus and price the securities on the same day.

14 Securities Act Release No. 8518 (December 22, 2004) [70 FR 1506] (the "ABS Adopting Release"), available on the Web at <http://sec.gov/rules/final/33-8518fr.pdf>.

  - o process related to disclosure of investors' requests to communicate with other investors related to exercising their rights under the terms of the transaction agreements;
- timely Exchange Act reporting in previous shelf offerings and timely filing of transaction requirements for previous shelf offerings for the prior 12 months from the time of filing of the shelf registration statement (for new shelf registrations) and 12 months from the ninetieth day after the year end of the depositor (for takedowns).

Form SF-3 expands the disclosure prospectus requirements for:

- Any originator if 10% or more of the total pool assets are originated by parties other than the sponsor or its affiliates.
- The identity of all originators.[15]
- Any sponsor or 20% originator that has an obligation to repurchase assets under the transaction agreements.
- Certain financial information about the sponsor's or an originator's financial condition if it represents 20% or more of the asset pool.
- The sponsor's retained economic interest in the transaction in order to comply with the law.
- The amount and nature of the retained interest, including the effect of any economic hedges.[16]
- Static pool information, including a narrative of the static pool information to aid investors in their review of such information, including methodologies applied to calculate such data and how the static pool differs from the pool assets underlying the securities being offered.
- A review of the pool assets designed to provide reasonable assurance that the disclosures of the pool assets in the prospectus are accurate in all material respects.
- Asset-level disclosures. Schedule AL contains 270 data points for MBS and 152 data points for commercial mortgage-backed securities. These data points are required for each mortgage in the pool and include information about the property, mortgage, obligor's creditworthiness, payment history, original and current mortgage terms, and loan performance information.
- Asset-level disclosures are required at registration and on an ongoing basis (via Exchange Act reporting), and are required to be provided in XML, a machine-readable format.

Offerings of MBS are required to comply with these new asset-level disclosure rules (listed here in Table 2.1) no later than November 23, 2016.

[15] Currently, Item 1110(a) of Regulation AB requires the disclosure of the identity of any originator that originates more than 10% of the total pool assets only.

[16] Sponsors must disclose their methodologies and assumptions used to calculate the amount of eligible residual interest in accordance with fair value standards under ASC 820.

Table 2.1 General disclosures in the prospectus/prospectus supplement

Form Items	Regulation AB, Existing requirement	New Regulation AB II Amendment	Information generally included in an 144A Private Placement Memorandum	Information generally included in an Agency MBS Offering Document
Item 1. Forepart of Registration Statement and Outside Front Cover Page of Prospectus	✓		✓	✓
Item 2. Inside Front and Outside Back Cover Pages of Prospectus	✓		✓	✓
Item 3. Summary Information, Risk Factors and Ratio of Earnings to Fixed Charges	✓		✓	✓
Item 4. Use of Proceeds	✓		✓	✓
Item 5. Determination of Offering Price	✓			
Item 6. Dilution. Table Figure	✓			
Item 7. Selling Security Holders	✓			
Item 8. Plan of Distribution	✓			✓
Item 9. Description of Securities to be Registered	✓			
Item 10. Interests of Named Experts and Counsel	✓			
Item 11. Material Changes	✓			
Item 12. Incorporation of Certain Information by Reference	✓			
Item 13. Disclosure of Commission Position on Indemnification for Securities Act Liabilities	✓			
Item 14. Other Expenses of Issuance and Distribution	✓		✓	
Item 15. Indemnification of Directors and Officers	✓			
Item 16. Exhibits	✓		✓	
Item 17. Undertakings	✓			
Item 1100. General	✓	✓	✓	✓
Item 1101. Definitions	✓	✓	✓	✓
Item 1102. Forepart of registration statement and outside cover page of the prospectus	✓	✓	✓	

Form Items	Regulation AB, Existing requirement	New Regulation AB II Amendment	Information generally included in an 144A Private Placement Memorandum	Information generally included in an Agency MBS Offering Document
Item 1103. Transaction summary and risk factors	✓	✓	✓	✓
Item 1104. Sponsors	✓	✓	✓	
Item 1105. Static pool information	✓	✓		
Item 1106. Depositors	✓		✓	✓
Item 1107. Issuing entities	✓		✓	
Item 1108. Servicers	✓	✓	✓	
Item 1109. Trustees	✓	✓	✓	✓
Item 1110. Originators	✓	✓	✓	
Item 1111. Pool assets	✓	✓	✓	✓
Item 1112. Significant obligors of pool assets	✓	✓	✓	
Item 1113. Structure of the transaction	✓	✓	✓	✓
Item 1114. Credit enhancement and other support, except for certain derivatives instruments	✓	✓	✓	
Item 1115. Certain derivatives instruments	✓			
Item 1116. Tax matters	✓		✓	✓
Item 1117. Legal proceedings	✓		✓	✓
Item 1118. Reports and additional information	✓		✓	✓
Item 1119. Affiliations and certain relationships and related transactions	✓	✓		
Item 1120. Ratings	✓		✓	
Item 1121. Distribution and pool performance information	✓	✓	✓	
Item 1122. Compliance with applicable servicing criteria	✓	✓	✓	
Item 1123. Servicer compliance statement	✓		✓	
Item 1124. Sponsor interest in the securities		✓		
Item 1125. Schedule AL—Asset-level information		✓		

Typical Sections of a Prospectus and Prospectus Supplement (Private-Label)

In the sections that follow, we will examine a sample of the types of information that are of most interest to prospective investors in the private-label MBS market. We will use an example of a Bank of America residential MBS to walk through the critical sections of the prospectus supplement.[17]

Cover and Summary of Terms

Disclosures on the cover page of a prospectus supplement are generally limited and provide a brief summary of the key deal attributes. The information includes a summary of the issuer, the type of collateral, the offered securities, and some class-specific data. Information regarding multiple classes is often not on the cover page due to space limitations. In these cases, the information is included in the summary form on the cover page, followed by a detailed table.

A quick glance at Figure 2.1, the cover page of the prospectus supplement, will allow the investor to identify several important pieces of information, such as:

- Bank of America, N.A. is selling and servicing $584,340,100 of fully amortizing, adjustable interest rate, one- to four-family, residential first lien mortgage loans, substantially all of which have original terms to stated maturity of approximately 10 to 30 years.
- The pool of assets will be divided into four loan collateral groups.
- There will be 11 classes of Senior Certificates offered by the three underwriters.
- The 11 classes receive credit enhancement from six classes of Class B Certificates.
- The Offered Certificates are expected to be delivered on or about January 27, 2005. Monthly payments of principal and interest will commence in February 2005.
- This document is a prospectus supplement and it must be accompanied by the base prospectus.

Figure 2.2, which follows the cover page, provides the investor with class-specific information about both the offered and non-offered certificates. The investors are presented with the expected initial rating of each certificate and a summary description of the principal type and interest type. A full description of the principal and interest types is disclosed in the base prospectus.

[17] Capitalized terms used herein are from the prospectus supplement of the Bank of America, N.A. Mortgage Pass-Through Certificates, Series 2005-A issuance, and are used for illustrative purposes only.

PROSPECTUS SUPPLEMENT
(To Prospectus Dated November 22, 2004)

Bank of America

Banc of America Mortgage Securities, Inc.
Depositor
Bank of America, N.A.
Seller and Servicer
$584,340,100
(Approximate)
Mortgage Pass-Through Certificates, Series 2005-A
Principal and interest payable monthly, commencing in February 2005

You should carefully consider the risk factors beginning on page S-16 of this prospectus supplement.

Neither the Offered Certificates nor the underlying mortgage loans are insured or guaranteed by any governmental agency or instrumentality.

The Offered Certificates will represent interests in the Trust only and will not represent interests in or obligations of Banc of America Mortgage Securities, Inc. or any other entity.

This prospectus supplement may be used to offer and sell the Offered Certificates only if accompanied by the prospectus.

The Trust will Issue–

- Four groups consisting of eleven classes of Senior Certificates.
- Six classes of Class B Certificates all of which are subordinated to, and provide credit enhancement for, the Senior Certificates. Each class of Class B Certificates is also subordinated to each class of Class B Certificates, if any, with a lower number.

The classes of Offered Certificates are listed under the heading"Offered Certificates" in the table beginning on page S-4.

The Assets of the Trust will Include–

- Four loan groups of fully amortizing, adjustable interest rate, one- to four-family, residential first mortgage loans, substantially all of which have original terms to stated maturity of approximately 10 to 30 years.

Neither the Securities and Exchange Commission nor any state securities commission has approved the Offered Certificates or determined that this prospectus supplement or the prospectus is accurate or complete. Any representation to the contrary is a criminal offense.

The Class A Certificates will be offered by the underwriters at varying prices to be determined at the time of sale to investors. The Class B Certificates offered by this prospectus supplement will be offered by Banc of America Securities LLC at varying prices to be determined at the time of sale to investors. The Offered Certificates are expected to be delivered on or about January 27, 2005. Total proceeds to the Depositor for the Offered Certificates will be approximately 99.811% of the initial principal balance of the Offered Certificates, before deducting expenses payable by the Depositor.

Banc of America Securities LLC
Bear, Stearns & Co. Inc. **Lehman Brothers**
January 21, 2005

FIGURE 2.1 Cover page

Source: Banc of America Mortgage Securities, Inc. Mortgage Pass-Through Certificates, Series 2005-A, Prospectus filed pursuant to rule 424, available at the Securities and Exchange Commission website <http://www.sec.gov>, Central Index Key (CIK) number 0001315171

THE SERIES 2005-A CERTIFICATES

Class	Initial Class Balance[1]	Pass-Through Rate	Principal Types[2]	Interest Types[2]	Initial Rating of Certificates[3] Moody's	Fitch
Offered Certificates						
Class 1-A-1	$ 99,118,000	(4)	Senior, Pass-Through	Variable Rate	Am	AAA
Class 1-A-R	$ 50	(4)	Senior, Sequential Pay	Variable Rate	None	AAA
Class 1-A-1.R	$ 50	(4)	Senior, Sequential Pay	Variable Rate	None	AAA
Class 2-A-1	$240,784,000	(5)	Senior, Pass-Through	Variable Rate	Am	AAA
Class 2-A-2	$141,000,000	(5)	Super Senior, Pass-Through	Variable Rate	Am	AAA
Class 2-A-3	$ 4,963,000	(5)	Super Senior Support, Pass-Through	Variable Rate	Aa 1	AAA
Class 3-A-1	$ 38,460,000	(6)	Senior, Pass-Through	Variable Rate	Am	AAA
Class 4-A-1	$ 43,554,000	(7)	Senior, Pass-Through	Variable Rate	Am	AAA
Class B-1	$ 10,583,000	(8)	Subordinated	Variable Rate	None	AA
Class B-2	$ 3,821,000	(8)	Subordinated	Variable Rate	None	A
Class B-3	$ 2,057,000	(8)	Subordinated	Variable Rate	None	BBB
Non-Offered Certificates						
Class 1-IO	(9)	(10)	Senior, Notional Amount	Fixed Rate, Interest Only	N/A	N/A
Class 2-IO	(9)	(11)	Senior, Notional Amount	Fixed Rate, Interest Only	N/A	N/A
Class 4-IO	(9)	(12)	Senior, Notional Amount	Fixed Rate, Interest Only	N/A	N/A
Class B-4	$ 1,470,000	(8)	Subordinated	Variable Rate	None	BB
Class B-5	$ 882,000	(8)	Subordinated	Variable Rate	None	B
Class B-6	$ 1,175,905	(8)	Subordinated	Variable Rate	None	None

FIGURE 2.2 Summary description of the Offered Certificates

Source: Banc of America Mortgage Securities, Inc. Mortgage Pass-Through Certificates, Series 2005-A, Prospectus filed pursuant to rule 424, available at the Securities and Exchange Commission website <http://www.sec.gov>, Central Index Key (CIK) number 0001315171

For example, the interest type associated with the Class 1-A-1 class is "Variable Rate," which is described in the base prospectus as "A Class of Certificates with an interest rate that resets periodically and is calculated by reference to the rate or rates of interest applicable to the Mortgage Loans." The more detailed explanation is provided in the footnotes in the prospectus supplement.

Footnotes 4 through 8 in Figure 2.3 provide the investor with detailed information about how the interest rate on each security will be calculated. Continuing our example for Class 1-A-1, the investor will receive interest at the weighted average of the Net Mortgage Interest Rates of the Group 1 Mortgage Loans. However, for the first 23 periods, that interest rate will be reduced by 0.3170%.

The temporary reduction in the Class 1-A-1 interest rate allows the creation of the Class 1-IO Certificate, which is described as an Interest-Only class. The interest rate of the Class 1-IO Certificate is fixed at 0.3170% for the first 23 periods, as explained in footnote 10 in the prospectus (not shown here). The base prospectus defines the Interest-Only type as "A Class of Certificates that is entitled to receive some or all of the interest payments made on the Mortgage Loans and little or no principal. Interest Only Certificates have either a nominal principal balance or a notional amount. A nominal principal balance represents actual principal that will be paid to the Class. It is referred to as nominal since it is generally very small in comparison to other Classes. The notional amount is used to calculate the amount of Interest due on a Class of Interest Only Certificates that is not entitled to any distributions in respect of principal."

A similar examination of the footnotes for Class 2-A-1, Class 3-A-1, and Class 4-A-1 reveals that the interest rates for these classes are linked to the Net Mortgage Interest

(1) Approximate. The initial class balance of the Offered Certificates may vary by a total of plus or minus 5%.

(2) See "Description of the Certificates — Categories of Classes of Certificates" in the Prospectus for a description of these principal and interest types and see "Description of the Certificates — Priority of Distributions" and "—Allocation of Losses" in this Prospectus Supplement for a description of the effects of subordination.

(3) See "Certificate Ratings" in this Prospectus Supplement.

(4) For each Distribution Date occurring prior to and including the Distribution Date in December 2007, interest will accrue on these Certificates at a per annum rate equal to the weighted average of the Net Mortgage Interest Rates on the Group 1 Mortgage Loans (based on the Stated Principal Balances of the Group 1 Mortgage Loans on the due date in the month preceding the month of such Distribution Date) minus 0.3170%. For each Distribution Date occurring on and after the Distribution Date in January 2008, interest will accrue on these Certificates at a per annum rate equal to the weighted average of the Net Mortgage Interest Rates of the Group 1 Mortgage Loans (based on the Stated Principal Balances of the Group 1 Mortgage Loans on the due date in the month preceding the month of such Distribution Date). For the initial Distribution Date in February 2005, this rate is expected to be approximately 4.103138% per annum.

(5) For each Distribution Date occurring prior to and including the Distribution Date in December 2009, interest will accrue on these Certificates at a per annum rate equal to the weighted average of the Net Mortgage Interest Rate of the Group 2 Mortgage Loans (based on the Stated Principal Balances of the Group 2 Mortgage Loans on the due date in the month preceding the month of such Distribution Date) minus 0.1710%. For each Distribution Date occurring on and after the Distribution Date in January 2010, interest will accrue on these Certificates at a per annum rate equal to the weighted average of the Net Mortgage Interest Rates of the Group 2 Mortgage Loans (based upon the Stated Principal Balances of the Group 2 Mortgage Loans on the due date in the month preceding the month of such Distribution Date). For the initial Distribution Date in February 2005, this rate is expected to be approximately 4.493991% per annum.

(6) Interest will accrue on these Certificates at a per annum rate equal to the weighted average of the Net Mortgage Interest Rates of the Group 3 Mortgage Loans (based upon the Stated Principal Balances of the Group 3 Mortgage Loans on the due date in the month preceding the month of such Distribution Date). For the initial Distribution Date in February 2005, this rate is expected to be approximately 5.059008% per annum.

(7) For each Distribution Date occurring prior to and including the Distribution Date in December 2014, interest will accrue on these Certificates at a per annum rate equal to the weighted average of the Net Mortgage Interest Rates of the Group 4 Mortgage Loans (based on the Stated Principal Balances of the Group 4 Mortgage Loans on the due date in the month preceding the month of such Distribution Date) minus 0.0323%. For each Distribution Date occurring on and after the Distribution Date in January 2015, interest will accrue on the Certificates at a rate equal to the weighted average of the Net Mortgage Interest Rates of the Group 4 Mortgage Loans (based upon the Stated Principal Balances of the Group 4 Mortgage Loans on the due date in the month preceding the month of such Distribution Date). For the initial Distribution Date in February 2005, this rate is expected to be approximately 5.230097% per annum.

(8) Interest will accrue on the Class B Certificates as of any Distribution Date at a per annum rate equal to the weighted average (based on the Group Subordinate Amount for each Loan Group) of (i) with respect to Loan Group 1, prior to and including the Distribution Date in December 2007, the weighted average of the Net Mortgage Interest Rates of the Group I Mortgage Loans (based on the Stated Principal Balances of the Group 1 Mortgage Loans on the due date in the month preceding the month of such Distribution Date) minus 0.3170% and on and after the Distribution Date in January 2008, the weighted average of the Net Mortgage Interest Rates of the Group 1 Mortgage Loans (based on the Stated Principal Balances of the Group 1 Mortgage Loans on the due date in the month preceding the month of such Distribution Date), (ii) with respect to Loan Group 2, prior to and including the Distribution Date in December 2009, the weighted average of the Net Mortgage Interest Rates of the Group 2 Mortgage Loans (based on the Stated Principal Balances of the Group 2 Mortgage Loans on the due date in the month preceding the month of such Distribution Date) minus 0.1710% and on and after the Distribution Date in January 2010, the weighted average of the Net Mortgage Interest Rates of the Group 2 Mortgage Loans (based on the Stated Principal Balances of the Group 2 Mortgage Loans on the due date in the month preceding the month of such Distribution Date), (iii) with respect to Loan Group 3, the weighted average of the Net Mortgage Interest Rates of the Group 3 Mortgage Loans (based on the Stated Principal Balances of the Group 3 Mortgage Loans on the due date in the month preceding the month of such Distribution Date) and (iv) with respect to Loan Group 4, prior to and including the Distribution Date in December 2014, the weighted average of the Net Mortgage Interest Rate of the Group 4 Mortgage Loans (based on the Stated Principal Balances of the Group 4 Mortgage Loans on the due date in the month preceding the month of such Distribution Date) minus 0.0323% and on

FIGURE 2.3 Passthrough rate description

Source: Banc of America Mortgage Securities, Inc. Mortgage Pass-Through Certificates, Series 2005-A, Prospectus filed pursuant to rule 424, available at the Securities and Exchange Commission website <http://www.sec.gov>, Central Index Key (CIK) number 0001315171

Rates of the Group 2, Group 3, and Group 4 Mortgage Loans respectively. The linkage of the interest rate between the collateral and the notes focuses the investor on the characteristics of the collateral for the pool supporting the various bond classes.

The class nomenclature is generally designed to provide investors with guidance about subordination and pool association. In our example, class names that begin with a number represent interests primarily in a specified group or portion of the mortgage loans.

Classes that are designated with the letter "B" are subordinate to those designated with the letter "A." Securitization transactions where all the offered securities are supported by the entire mortgage pool do not begin with a number. Readers are cautioned to examine the full description of the securities presented in the base prospectus and prospectus supplement when assessing and evaluating subordination and pool characteristics.

Asset Pool Information

Information about the composition and characteristics of the asset pool is a fundamental disclosure considered by investors in making an informed investment decision regarding an MBS. The asset pool is often the only or the principal source of cash flows to service the private-label MBS. The material characteristics of each pool will vary, depending on the nature of the pool assets. Different issuers present different information to facilitate an analysis of the collateral pool. However, there are certain general categories of disclosure that are provided for pool characteristics. The pool is often divided or stratified into ranges of values or characteristics. Typically, the number and balance of each type of loan will be displayed. See Figure 2.4 for an example of asset pool stratification.

The typical categories of disclosure for RMBS include the:

- type of residential property securing the mortgage;
- purpose of the mortgage loan;
- occupancy status of the mortgage property;
- geographic location and concentration of the mortgaged properties;
- range of mortgage loan principal balances;
- range of loan-to-value ratios at the time of origination;
- range of current interest rates;
- range of remaining terms;
- credit scores of the mortgagors at the time of loan origination.

The categories of disclosure for commercial mortgage backed securities[18] may include:

- location and type of each mortgaged property;
- net operating income and net cash flow information for each mortgaged property;
- occupancy rates for each mortgaged property;
- information about the largest tenants at each mortgage property, including square feet occupied and lease expiration dates;
- amount of all other material mortgages, liens, or encumbrances against the mortgaged property.

Under Regulation AB II, significantly more granular data points will be required to be disclosed in Schedule AL (effective for all registered transactions on November 23, 2016). There are 270 data points for residential MBS and 152 data points for commercial MBS determined by the SEC. The data set is based primarily on information that Fannie Mae and Freddie Mac require in connection with purchases of mortgage loans, and the disclosure and reporting package developed by Project RESTART[19] and CRE

[18] See Part V for more information about commercial mortgage-backed securities.

[19] This is the American Securitization Forum's Project on Residential Securitization Transparency and Reporting.

Group 1 Mortgage Loan Data

The following tables set forth certain characteristics of the Group 1 Mortgage Loans as of the Cut-off Date. The balances and per-centages may not be exact due to rounding.

Occupancy of Mortgaged Properties(1)

Occupancy	Number of Group 1 Mortgage Loans	Aggregate Stated Principal Balance as of Cut-off Date	% of Group 1 Cut-off Date Pool Principal Balance
Primary Residence	160	$ 85,079,397.26	82.92%
Second Home	24	13,705,717.24	13.36
Investor Property	8	3,821,695.74	3.72
Total	192	$ 102,606,810.24	100.00%

(1) Based solely on representations of the mortgagor at the time of origination of the related Group 1 Mortgage Loan.

Property Types

Property Type	Number of Group 1 Mortgage Loans	Aggregate Stated Principal Balance as of Cut-off Date	% of Group 1 Cut-off Date Pool Principal Balance
Single Family Residence	107	$ 57,396,155.57	55.94%
PUD-Detached	45	24,774,292,.68	24.14
Condominium	30	14,835,336.54	14.46
4-Family	2	1,704,096.25	1.66
PUD-Attached	4	1,643,053.27	1.60
2-Family	2	1,261,084.15	1.23
Cooperative	1	599,191.78	0.58
3-Family	1	393,600.00	0.38
Total	192	$102,606,810.24	100.00%

Mortgage Loan Purposes

Purpose	Number of Group 1 Mortgage Loans	Aggregate Stated Principal Balance as of Cut-off Date	% of Group 1 Cut-off Date Pool Principal Balance
Purchase	101	$ 53,265,242.93	51.94%
Refinance—Rate/Term	58	32,317,407.44	31.50
Refinance—Cashout	33	17,024,159.87	16.59
Total	192	$102,606,810.24	100.00%

FIGURE 2.4 Asset pool stratification

Source: Banc of America Mortgage Securities, Inc. Mortgage Pass-Through Certificates, Series 2005-A, Prospectus filed pursuant to rule 424, available at the Securities and Exchange Commission website <http://www.sec.gov>, Central Index Key (CIK) number 0001315171

Finance Council Investor Reporting Package, two industry-wide projects championed by market participants.

In addition to the pool stratification information, the issuer presents historic delinquency and loss information. Historically mortgage transactions only securitized non-delinquent mortgage loans. The issuer discloses the delinquency status and loss history of similar loans originated or acquired by the depositor.[20] These disclosures are often stratified into groupings or "buckets" with delinquency information and percentages.

The delinquency "buckets" are presented in 30- or 31-day increments through the point that assets are written off or charged off as uncollectible (Figure 2.5). Information is provided on how delinquencies, charge-offs, and uncollectible accounts are defined, delinquency, and default management practices such as grace periods, payment skipping programs, re-aging, restructuring, and other loss mitigation strategies.

The combined data for the current asset pool, along with the historical information about delinquencies and defaults, provides the investor with information to evaluate the potential performance of the collateral pool. For those investors that choose to reverse-engineer[21] a transaction, the collateral pool data is used to establish the ranges of prepayment, loss, and recovery assumptions.

Description of the Certificates

The core of each prospectus supplement is the description of the offered certificates. Section 220 of Regulation S-K[22] defines the required description. The issuer must disclose information such as:

- provisions with respect to maturity, conversion, redemption, amortization, or retirement;
- denominations and form (see Figure 2.6);
- terms and conditions of book-entry securities;
- date and frequency of distributions;

[20] Regulation AB II will require an officer certification regarding the compliance of the pool assets with representations and warranties disclosed in the prospectus, disclosure of an asset review by the sponsor, and disclosure of repurchases of certain delinquent assets.

[21] In general, reverse-engineering is to ascertain the functional basis of something by taking it apart and studying how it works. In the context of MBS, reverse-engineering a transaction refers to the process by which an investor or other party creates a mathematical model to calculate future payments of principal and interest to one or more of the securities in a transaction. In a two-step process, known information about the asset pool (balance, coupon, term) is combined with assumed information (prepayment speed, default, recovery, and interest rate information) to project collateral cash flows. The second step uses the collateral cash flows for each period to make projected class cash flows. These projected class cash flows serve as the basis for valuing the MBS.

[22] 17 Code of Federal Regulations 229.202 et seq.

Foreclosure and Delinquency Experience of Bank of America

The following table summarizes the delinquency and foreclosure experience on the portfolio of one- to four-family first mortgage loans originated or acquired by Bank of America or certain of its affiliates and serviced or subserviced by Bank of America, or serviced by Bank of America for others, other than (i) mortgage loans acquired through certain mergers with previously unaffiliated entities, (ii) mortgage loans with respect to which the servicing rights were acquired by Bank of America in bulk and (iii) certain mortgage loans originated at bank branches of Bank of America.

The portfolio of mortgage loans serviced by Bank of America includes both fixed and adjustable interest rate mortgage loans, including "buydown" mortgage loans, loans with balances conforming to FHLMC's and FNMA's limits as well as jumbo loans, loans with stated maturities of 10 to 40 years and other types of mortgage loans having a variety of payment characteristics, and includes mortgage loans secured by mortgaged properties in geographic locations that may not be representative of the geographic distribution or concentration of the mortgaged properties securing the Mortgage Loans in any Series. There can be no assurance that the delinquency, foreclosure and loss experience set forth below will be similar to the results that may be experienced with respect to the Mortgage Loans in a Series.

Bank of America, N.A
Delinquency and Foreclosure Experience on Mortgage Loans

	At December 31, 2004		At December 31, 2003		At December 31, 2002	
	Number/ % of Mortgage Loans	Outstanding Principal Amount (In Millions)	Number/ % of Mortgage Loans	Outstanding Principal Amount (In Millions)	Number/ % of Mortgage Loans	Outstanding Principal Amount (In Millions)
Total Portfolio	1,300,762	$194,743,4	1,229,050	$174,777.5	1,202,522	$168,063.2
Delinquencies*						
One Installment delinquent	16,251	$ 1,802.3	20,406	$ 2,219.3	25,415	$ 2,991.5
Percent Delinquent	1.2%	0.9%	1.7%	1.3%	2.1%	1.8%
Two Installments delinquent	4,224	$ 4283	5,399	$ 549.9	5,952	$ 625.2
Percent Delinquent	0.3%	0.2%	0.4%	0.3%	0.5%	0.4%
Three or more installments delinquent	4,935	$ 484.0	6,294	$ 615.8	6,373	$ 649.5
Percent Delinquent	0.4%	0.2%	0.5%	0.4%	0.5%	0.4%
In Foreclosure	4,296	$ 399.2	5,449	$ 548.2	5,855	$ 590.1
Percent in Foreclosure	0.3%	0.2%	0.4%	0.3%	0.5%	0.4%
Delinquent and in Foreclosure	29,706	$ 3,113.8	37,548	$ 3,933.2	43,595	$ 4,836.4
Percent Delinquent and in Foreclosure**	2.3%	1.6%	3.1%	2.3%	3.6%	2.9%

* **A mortgage loan is deemed to have "one installment delinquent" if any scheduled payment of principal or interest is delinquent past the end of the month in which such payment was due, "two installments delinquent" if such delinquency persists past the end of the month following the month in which such payment was due, and so forth.**

** **The sums of the Percent Delinquent and Percent in Foreclosure set forth in this table may not equal the Percent Delinquent and in Foreclosure due to rounding.**

FIGURE 2.5 Delinquency and foreclosure information

Source: Banc of America Mortgage Securities, Inc. Mortgage Pass-Through Certificates, Series 2005-A, Prospectus filed pursuant to rule 424, available at the Securities and Exchange Commission website <http://www.sec.gov>, Central Index Key (CIK) number 0001315171

- source of cash flow available for distribution—often the "Pool Distribution Amount" (see Figure 2.7);
- priority of distributions (see Figure 2.8);
- method of calculating and distributing interest;
- method of calculating and distributing principal.

A clear description of the flow of funds for the transaction is important. The description includes allocations of payments, and distribution priorities among all classes of the securities. The issuer should clearly communicate the credit enhancement and any

DESCRIPTION OF THE CERTIFICATES

The Certificates will consist of (i) the eleven classes of Offered Certificates listed in the table on page S-4 of this Prospectus Supplement and (ii) the Class 1-IO, Class 2-IO, Class 4-IO, Class B-4, Class B-5 and Class B-6 Certificates, which are not offered by this Prospectus Supplement.

The Class 1-IO, Class 2-IO and Class 4-IO Certificates are Interest Only Certificates. On and after the Distribution Date in January 2008, the Class 1-IO Certificates will no longer be entitled to payments of interest. On and after the Distribution Date in January 2010, the Class 2-IO Certificates will no longer be entitled to payments of interest. On and after the Distribution Date in January 2015, the Class 4-IO Certificates will no longer be entitled to payments of interest.

The Group 1-A Certificates in the aggregate will evidence an initial beneficial ownership interest of approximately 96.06% in Loan Group I, the Group 2-A Certificates in the aggregate will evidence an initial beneficial ownership interest of approximately 96.60% in Loan Group 2, the Group 3-A Certificates in the aggregate will evidence an initial beneficial ownership interest of approximately 96.60% in Loan Group 3 and the Group 4-A Certificates in the aggregate will evidence an initial beneficial ownership interest of approximately 96.60% in Loan Group 4. The Class B Certificates in the aggregate represent the remaining initial beneficial ownership interest in each Loan Group.

The **"Final Scheduled Maturity Date"** for the Certificates will be the Distribution Date in February 2035. The Final Scheduled Maturity Date represents the Distribution Date in the month following the latest maturity date of any Mortgage Loan in the Mortgage Pool. The actual final payment on your Certificates could occur earlier or later than the Final Scheduled Maturity Date.

Denominations and Form

The Offered Certificates (other than the Class 1-A-R and Class 1-A-LR Certificates) will be issuable in book-entry form only (the **"Book-Entry Certificates"**). The Class 1-A-R and Class 1-A-LR Certificates will be issued in definitive, fully-registered form (such form, the **"Definitive Certificates"**). The following table sets forth the original Certificate form, the minimum denomination and the incremental denomination of the Offered Certificates. The Offered Certificates are not intended to be and should not be directly or indirectly held or beneficially owned in amounts lower than such minimum denominations. A single certificate of each class may be issued in an amount different than described above.

Form and Denominations of Offered Certificates

Class	Original Certificate Form	Minimum Denomination	Incremental Denomination
Classes 1-A-1, 2-A-1, 2-A-2, 2-A-3, 3-A-1 and 4-A-1	Book-Entry	$ 1,000	$ 1
Classes 1-A-R and 1-A-LR..	Definitive	$ 50	N/A
Classes B-1, B-2 and B-3..	Book-Entry	$25,000	$ 1

FIGURE 2.6 Description of the Offered Certificates

Source: Banc of America Mortgage Securities, Inc. Mortgage Pass-Through Certificates, Series 2005-A, Prospectus filed pursuant to rule 424, available at the Securities and Exchange Commission website <http://www.sec.gov>, Central Index Key (CIK) number 0001315171

other structural features in the transaction that are designed to protect the investor's interests.[23] The description includes any requirements that direct or redirect cash flows to reserve accounts, along with a description of the purpose of those requirements. In addition to the narrative description, many issuers present the flow of funds

[23] Under new Regulation AB II, an ABS issuer must file a post-effective amendment to the registration statement if there were new structural features or credit enhancement that were not originally described in the base prospectus.

Distributions

Distributions on the Certificates will be made by the Trustee on the 25th day of each month (or, if not a business day, the next business day), commencing in February 2005 (each, a **"Distribution Date"**), to the persons in whose names such Certificates are registered at the close of business on the last business day of the month preceding the month of such Distribution Date (the **"Record Date"**).

Distributions on each Distribution Date will be made by check mailed to your address as it appears on the applicable certificate register or, if you have notified the Trustee in writing in accordance with the Pooling Agreement, by wire transfer in immediately available funds to your account at a bank or other depository institution having appropriate wire transfer facilities. However, the final distribution in retirement of a Certificate will be made only upon presentment and surrender of the Certificate at the Corporate Trust Office of the Trustee in Minnesota. If you own a Book-Entry Certificate, distributions will be made to you through the facilities of DTC, as described above under "— Book-Entry Certificates."

Pool Distribution Amount

The **"Pool Distribution Amount"** for each Loan Group with respect to any Distribution Date will be determined by reference to amounts received and expenses incurred in connection with the Mortgage Loans in such Loan Group and will be equal to the sum of:

(i) all scheduled installments of interest (net of the related Servicing Fee) and principal due on the Mortgage Loans in such Loan Group on the due date in the month in which such Distribution Date occurs and received prior to the related Determination Date, together with any Advances in respect thereof or any Compensating Interest allocable to the Mortgage Loans in such Loan Group;

(ii) all proceeds of any primary mortgage guaranty insurance policies and any other insurance policies with respect to the Mortgage Loans in such Loan Group, to the extent such proceeds are not applied to the restoration of the related Mortgaged Property or released to the mortgagor in accordance with the Servicer's normal servicing procedures and all other cash amounts received and retained in connection with the liquidation of defaulted Mortgage Loans in such Loan Group, by foreclosure or otherwise (collectively, **"Liquidation Proceeds"**), during the calendar month preceding the month of such Distribution Date (in each case, net of unreimbursed expenses incurred in connection with a liquidation or foreclosure and unreimbursed Advances, if any);

(iii) all partial or full prepayments received on the Mortgage Loans in such Loan Group during the calendar month preceding the month of such Distribution Date; and

(iv) amounts received with respect to such Distribution Date as the Substitution Adjustment Amount or Purchase Price in respect of any Deleted Mortgage Loan in such Loan Group or amounts received in connection with the optional termination of the Trust as of such Distribution Date, reduced by amounts in reimbursement for Advances previously made and other amounts as to which the Servicer is entitled to be reimbursed pursuant to the Pooling Agreement.

The Pool Distribution Amounts will not include any amounts constituting Servicing Compensation.

FIGURE 2.7 Source of cash flows available for distribution

Source: Banc of America Mortgage Securities, Inc. Mortgage Pass-Through Certificates, Series 2005-A, Prospectus filed pursuant to rule 424, available at the Securities and Exchange Commission website <http://www.sec.gov>, Central Index Key (CIK) number 0001315171

To each Group, from the applicable Pool Distribution Amount:

(i) to the Trustee an amount in payment for its services for such Distribution Date;

(ii) to the Class IO Certificates of such Group, if any, to pay interest;

(iii) to each class of Class A Certificates of such Group to pay interest;

(iv) to the classes of Class A Certificates of such Group entitled to receive distributions of principal, based on the applicable Senior Principal Distribution Amount, as described below under "— Principal," to pay principal;

(v) to each class of Subordinate Certificates, first to pay interest and then to pay principal in the order of their numerical class designations, beginning with the Class B-1 Certificates; and

(vi) to the Class 1-A-R and Class 1-A-LR Certificates, any remaining amounts in the Upper-Tier REMIC and Lower-Tier REMIC, respectively, subject to the limitations set forth below under "— Interest" and "— Principal."

Certain amounts otherwise distributable on the Subordinate Certificates may be used to pay other classes as described under "Description of the Certificates—Cross Collateralization" herein.

FIGURE 2.8 Priority of distributions

Source: Banc of America Mortgage Securities, Inc. Mortgage Pass-Through Certificates, Series 2005-A, Prospectus filed pursuant to rule 424, available at the Securities and Exchange Commission website <http://www.sec.gov>, Central Index Key (CIK) number 0001315171

graphically to clearly communicate the sequence of distributions and cash flow priorities.

In our example transaction in Figure 2.8, we can see that Class 1-A-1's interest payment is third in priority, while its principal payment is fourth in priority. In other words, payments to Class 1-A-1 are subordinate to payment of the trustee fee and payment of interest to the Class IO Certificates. The issuer has described the priority of payment among the Senior and Subordinate Certificates graphically (see Figure 2.9).

Other disclosures explain when any early or accelerated amortization, performance, or other triggers or events may occur. In Figure 2.10, we see an example of such a trigger event. In this case, the Senior Prepayment Percentage is used to determine the amount of collateral prepayments allocated to the Senior Securities, and the prepayment allocations to the Subordinate Securities.[24] The table illustrates the shift in the percentage of prepayments depending on the date or timing of distributions.

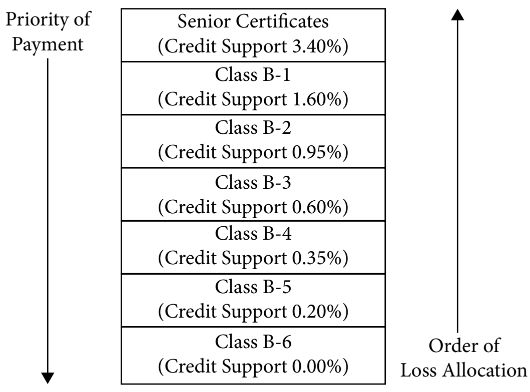
Moving from one percentage to another is dependent upon the satisfaction of the tests outlined in the paragraphs beginning with the phrase "provided, however." An investor seeking to build an accurate model of the transaction should consider these conditions and the related assumptions.

[24] See Chapter 20 on non-agency CMOs for more information about the shifting interest structure.

Credit Support

Credit support for the Offered Certificates is provided by subordination as follows:

Subordination of Class B Certificates[1]



(1) The credit support percentage set forth in this chart shows the initial balance of the classes of Certificates subordinate to a class or classes as a percentage of the initial aggregate scheduled principal balance of the Mortgage Loans.

FIGURE 2.9 Graphical description of the priority of payment of the Certificates

Source: Banc of America Mortgage Securities, Inc. Mortgage Pass-Through Certificates, Series 2005-A, Prospectus filed pursuant to rule 424, available at the Securities and Exchange Commission website <http://www.sec.gov>, Central Index Key (CIK) number 0001315171

In our example the issuer has also included a description of the effects of the shifting interest structure on the classes:

> This disproportionate allocation of certain unscheduled payments in respect of principal will have the effect of accelerating the amortization of the Class A Certificates of a Group while, in the absence of Realized Losses on the Mortgage Loans in the related Loan Group, increasing the relative interest in the Pool Principal Balance evidenced by the Subordinate Certificates. Increasing the interest of the Subordinate Certificates relative to that of the Class A Certificates of such Group is intended to preserve the availability of the subordination provided by the Subordinate Certificates.

Other disclosures include the frequency of distributions and the distribution dates. Investors should understand the related collection periods for the pool assets, and how cash is collected, invested, and transferred to various parties to the trust. Other cash management concerns include permissible short-term investments when cash is deposited into a Trust account. The issuer will generally disclose which party to the transaction has the authority to make these investment decisions and the party responsible for any investment losses.

The **"Senior Prepayment Percentage"** for a Loan Group for any Distribution Date occurring during the periods set forth below will be as follows:

Distribution Date Occuring In	Senior Prepayment Percentage
February 2005 through January 2012	100%;
February 2012 through January 2013	the applicable Senior Percentage, plus 70% of the applicable Subordinate Percentage;
February 2013 through January 2014	the applicable Senior Percentage, plus 60% of the applicable Subordinate Percentage;
February 2014 through January 2015	the applicable Senior Percentage, plus 40% of the applicable Subordinate Percentage;
February 2015 through January 2016	the applicable Senior Percentage, plus 20% of the applicable Subordinate Percentage; and
February 2016 and thereafter	the applicable Senior Percentage;

provided, however, (i) if on any Distribution Date the percentage equal to (x) the sum of the class balances of the Class A Certificates of all Groups divided by (y) the aggregate Pool Principal Balance for all Loan Groups (such percentage, the **"Total Senior Percentage"**) exceeds such percentage calculated as of the Closing Date, then the Senior Prepayment Percentage for all Loan Groups for such Distribution Date will equal 100%, (ii) if on any Distribution Date prior to the February 2008 Distribution Date, prior to giving effect to any distributions, the percentage equal to the aggregate class balance of the Subordinate Certificates divided by the aggregate Pool Principal Balance for all Loan Groups (the **"Aggregate Subordinate Percentage"**) is greater than or equal to twice such percentage calculated as of the Closing Date, then the Senior Prepayment Percentage for each Loan Group for such Distribution Date will equal the Senior Percentage for such Loan Group plus 50% of the Subordinate Percentage for such Loan Group and (iii) if on or after the February 2008 Distribution Date, prior to giving effect to any distributions, the Aggregate Subordinate Percentage is greater than or equal to twice such percentage calculated as of the Closing Date, then the Senior Prepayment Percentage for each Loan Group for such Distribution Date will equal the Senior Percentage for such Loan Group.

No decrease in the share of the applicable Subordinate Percentage (for calculating the applicable Senior Prepayment Percentage) will occur, and the Senior Prepayment Percentages for such prior period will be calculated without regard to clause (ii) or (iii) of the paragraph above, if as of any Distribution Date as to which any such decrease applied, (i) the outstanding principal balance of all Mortgage Loans (including, for this purpose, any Mortgage Loans in foreclosure, any REO Property and any Mortgage Loan for which the mortgagor has filed for bankruptcy after the Closing Date) delinquent 60 days or more (averaged over the preceding six-month period), as a percentage of the aggregate class balance of the Subordinate Certificates, is equal to or greater than 50% or (ii) cumulative Realized Losses with respect to the Mortgage Loans exceed the percentages of the aggregate class balance of the Subordinate Certificates as of the Closing Date (the **"Original Subordinate Principal Balance"**) indicated below:

FIGURE 2.10 Trigger event disclosure

Source: Banc of America Mortgage Securities, Inc. Mortgage Pass-Through Certificates, Series 2005-A, Prospectus filed pursuant to rule 424, available at the Securities and Exchange Commission website <http://www.sec.gov>, Central Index Key (CIK) number 0001315171

The final piece of information regarding the securities is the certification of any residual or retained interests to the cash flows.[25] Investors should consider the disposition of all collateral cash flows, including excess cash flows not used to pay fees or make payments to other Certificate holders.

In our example, any excess cash flows are directed to the Class 1-A-R and 1-A-LR Certificates (Figure 2.8). The issuer discloses that:

> the holder of the Class 1-A-LR Certificate will be entitled to receive any Pool Distribution Amount for a Loan Group remaining after the payment of (i) interest and principal on the Senior Certificates of the related Group and (ii) interest and principal on the Subordinate Certificates, as described above. It is not anticipated that there will be any significant amounts remaining for any such distribution.

Fees and Expenses

The investor should consider the disposition of all collateral cash flows to fully evaluate the economics of the transaction. The issuer discloses all fees and expenses involved in an MBS transaction. The fee and expense information states the amount of the fee or expense, its general purpose, the party receiving such fees or expenses, the source of funds for such fees or expenses, and the distribution priority of such amounts.

Frequently, fees or expenses are not fixed, and vary based on the value of the collateral pool. In these cases, the issuer discloses the formula or method of calculation used to determine the fee or expense.

Figure 2.11 describes the two components of the Administration Fee. The first component is the per annum Trustee Fee Rate, equal to 0.0045% of the principal balance.

The second component is the Servicing Fee Rate, which unlike the Trustee Fee, varies according to the asset pool. The Servicing Fee Rate is 0.375% per annum for Loan Group 1 and 0.250% per annum for Loan Group 2, Loan Group 3, and Loan Group 4.

In addition to the Servicing Fee, the Servicer is entitled to three other sources of compensation:

- Ancillary Income (penalties for late payments and other fees paid by borrowers),
- Custodial Account income, and
- any Foreclosure Profits.

In addition to the Trustee Fee, the Trustee is entitled to investment income earned on the funds on deposit in certain Trust accounts.

[25] Sponsors must disclose the methodologies and assumptions used to calculate its economic interest in accordance with fair value. Credit Risk Retention requirements ("CRR") of section 15G of the Securities Exchange Act of 1934 as added by section 941 of the Dodd-Frank Rule (the "Rule").

Compensation and Payment of Expenses of the Servicer and the Trustee

The Administrative Fees with respect to a Loan Group are payable out of the interest payments received on each Mortgage Loan in the related Loan Group. The **"Administrative Fees"** consist of (a) a servicing fee payable to the Servicer in respect of its servicing activities (the **"Servicing Fee")** and (b) fees paid to the Trustee. The Administrative Fees will accrue on the Stated Principal Balance of each Mortgage Loan as of the due date in the month preceding the month of the related Distribution Date at a rate (the **"Administrative Fee Rate"**) equal to the sum of the Servicing Fee Rate and the Trustee Fee Rate. The **"Trustee Fee Rate"** will be 0.0045% per annum. The **"Servicing Fee Rate"** with respect to each Mortgage Loan will be 0.375% per annum for Loan Group 1 and 0.250% per annum for Loan Group 2, Loan Group 3 and Loan Group 4, respectively.

The **"Servicing Compensation"** to the Servicer will equal the sum of (i) the Servicing Fee, (ii) any Ancillary Income, (iii) net income from investment of funds in the Servicer Custodial Account and (iv) Foreclosure Profits (as defined in the Prospectus under "Description of the Certificates—Distributions to Certificateholders."

"Ancillary Income" includes all late payment fees, assumption fees, prepayment premiums and other similar charges.

The Servicer is obligated to pay certain ongoing expenses associated with the Trust and incurred by the Servicer in connection with its responsibilities under the Pooling Agreement. Those amounts will be paid by the Servicer out of its Servicing Compensation. The amount of the Servicer's Servicing Compensation is subject to adjustment with respect to prepaid Mortgage Loans, as described below under "—Compensating Interest."

The Trustee is also entitled to all investment income earned on amounts on deposit in the Certificate Account. In addition to its compensation, the Trustee is entitled to be reimbursed from and indemnified by the Trust for certain expenses incurred by the Trustee in connection with its responsibilities under the Pooling Agreement.

Compensating Interest

When a Mortgage Loan is subject to a partial prepayment or is prepaid in full between due dates, the mortgagor is required to pay interest on the amount prepaid only to the date of prepayment in the case of a prepayment in full or to the due date in the month in which a partial prepayment is made. No interest will be paid by the mortgagor on the amount prepaid after those dates. Prepayments will be distributed to certificateholders on the Distribution Date in the month following the month of receipt.

Pursuant to the Pooling Agreement, the aggregate Servicing Fee payable to the Servicer for any month will be reduced (but not below zero) by an amount equal to the lesser of (i) the Prepayment Interest Shortfall for such Distribution Date and (ii) one-twelfth of 0.25% of the aggregate Stated Principal Balance of the Mortgage Loans as of the due date in the month preceding the month of such Distribution Date (such amount, **"Compensating Interest"**).

The **"Prepayment Interest Shortfall"** is equal to the difference between (x) 30 days' interest at the mortgage interest rate (less the Servicing Fee Rate) on the amount of each prepayment on the Mortgage Loans minus (y) the amount of interest actually paid by the related mortgagors on the amount of such prepayments during the preceding month.

FIGURE 2.11 Description of fees

Source: Banc of America Mortgage Securities, Inc. Mortgage Pass-Through Certificates, Series 2005-A, Prospectus filed pursuant to rule 424, available at the Securities and Exchange Commission website <http://www.sec.gov>, Central Index Key (CIK) number 0001315171

Optional Redemption

Similar to more traditional fixed-income securities, understanding the optional or mandatory redemption or termination provisions may be significant to an investor's analysis of the value of an investment. Most MBS transactions contain "clean-up" calls if the principal balance of the pool assets reaches a specified minimum level. The clean-up call allows a specified party to call the securities and terminate the trust before the stated maturity date of the securities.

Issuers and servicers are motivated to exercise clean-up calls when the administrative costs exceed the servicing fees earned on the remaining securities and are typically contingently exercisable when less than 10% of the original pool principal balance is outstanding. Typically, any class of securities with an optional redemption or termination feature that may be exercised when 25% or more of the original principal balance of the pool is outstanding usually includes the word "callable." The term callable advises investors that the optional redemption feature is greater than a typical MBS clean-up call.

In the example transaction, the first paragraph in Figure 2.12 discloses what party has the right to terminate, and under what condition. Specifically, the prospectus supplement says "the Depositor will have the option to purchase all remaining Mortgage Loans and other assets in the Trust when the scheduled balance of the Mortgage Pool as of the Distribution Date on which the purchase proceeds are to be distributed is less than 10% of the initial balance of the Mortgage Pool."

The first paragraph in Figure 2.12 goes on to disclose the required purchase price of the assets of the trust. Specifically, the prospectus supplement indicates that the purchase price: "will generally be equal to the sum of

(a) the Stated Principal Balances of the Mortgage Loans [...]
(b) the fair market value of any REO Properties held by the Trust [...]
(c) the amount of any unpaid interest shortfalls on the Certificates and
(d) one month's interest on the Stated Principal Balance of each Mortgage Loan."

The second paragraph in Figure 2.12 discloses how the purchase price proceeds will be distributed to Certificate holders. There is the possibility that the proceeds from such a distribution may not be sufficient to distribute the full amount due to a class if the purchase price of the REO property is less than the scheduled balance of the related Mortgage Loan.

An investor seeking to model a transaction should include an optional redemption trigger in the model. The model results can illustrate the change in yield and duration if the optional redemption is exercised.

Credit Enhancement and Other Support

To fully understand and analyze the securities, investors need to consider all of the available credit enhancements and support throughout the lifecycle of the transaction. The prospectus supplement describes both internal and external credit enhancement.

Optional Termination

The circumstances under which the obligations created by the Pooling Agreement will terminate in respect of the Certificates are described in "The Pooling and Servicing Agreement — Termination; Optional Purchase of Mortgage Loans" in the Prospectus. In addition, the Depositor will have the option to purchase all remaining Mortgage Loans and other assets in the Trust when the scheduled balance of the Mortgage Pool as of the Distribution Date on which the purchase proceeds are to be distributed is less than 10% of the initial balance of the Mortgage Pool. This percentage may be reduced through an amendment to the Pooling Agreement under the circumstances described below. The purchase price will generally be equal to the sum of (a) the Stated Principal Balances of the Mortgage Loans and (b) the fair market value of any REO Properties held by the Trust together with the amount of any unpaid interest shortfalls on the Certificates and one month's interest on the Stated Principal Balance of each Mortgage Loan. However, for so long as the Depositor is subject to regulation by the OCC, the FDIC, the Federal Reserve or the OTS, the Depositor may exercise its purchase option only if the aggregate fair market value of the Mortgage Loans and REO Properties is greater than or equal to the purchase price described in the preceding sentence.

Distributions in respect of an optional purchase described above will be paid to certificateholders in order of their priority of distribution as described below under "Description of the Certificates — Priority of Distributions." The proceeds from such a distribution may not be sufficient to distribute the full amount

to which each class is entitled if the purchase price is based in part on the fair market value of the REO Property and such fair market value is less than the scheduled balance of the related Mortgage Loan.

The Pooling Agreement may be amended without the consent of certificateholders in order to reduce the percentage of the initial balance of the Mortgage Pool at which the Depositor will have the option to purchase all the remaining Mortgage Loans, if such reduction is considered necessary by the Depositor, as evidenced by an officer's certificate delivered to the Trustee, to preserve the treatment of the transfer of the Mortgage Loans to the Depositor by Bank of America or to the Trust by the Depositor as a sale for accounting purposes.

In no event will the Trust created by the Pooling Agreement continue beyond the later of (a) the repurchase described above, if it results in the Trust no longer owning any Mortage Loans, (b) the expiration of 21 years from the death of the survivor of the person named in the Pooling Agreement and (c) the final distribution to certificateholders of amounts received in respect of the assets of the Trust. The termination of the Trust will be effected in a manner consistent with applicable federal income tax regulations and the REMIC status of the Upper-Tier REMIC and Lower-Tier REMIC.

FIGURE 2.12 Optional redemption

Source: Banc of America Mortgage Securities, Inc. Mortgage Pass-Through Certificates, Series 2005-A, Prospectus filed pursuant to rule 424, available at the Securities and Exchange Commission website <http://www.sec.gov>, Central Index Key (CIK) number 0001315171

Examples of external credit or liquidity enhancement include:

- bond insurance or guarantees for a specific class or group of classes;
- mortgage pool insurance policy;
- credit derivative agreements;
- interest rate swap agreements;
- interest rate cap or floor agreements;
- currency exchange agreements.

Examples of structural credit enhancement include:

- subordination (senior and subordinate structures);
- early amortization or redirected cash flows;
- over-collateralization with assets;
- cross-collateralization within the structure among different classes;
- reserve accounts;
- interest spread accounts, or other amounts funded from collateral cash flows.

In the sample transaction, Figure 2.13 illustrates the disclosure of internal credit enhancement features using subordination and cross-collateralization. The document briefly discusses the potential impact to both the senior and subordinate classes. The effect of the cross-collateralization provision is the principal payment from one loan group that would otherwise be distributable to the Class B Certificates may be allocated to the Class A Certificates for an unrelated loan group.

The prospectus supplement also discloses the effect of the "shifting interest in prepayments" provision (Figure 2.13), and how the subordination level is maintained through the use of conditions and triggers (Figure 2.10). The allocation of all principal prepayments to the Class A Certificates for the first seven years will result in accelerating the amortization of those Class A Certificates relative to the subordinate securities. This acceleration will likely result in the gradual increase in the credit support percentage for the Class A Certificates.

An investor seeking to build a model of the transaction must include both internal and external credit enhancement features. The investor should develop scenarios using various loss and prepayment assumptions on the resulting cash flows for both the senior and subordinate securities.

Prepayment and Yield Considerations

The yield and prepayment section of the prospectus supplement receives significant attention from prospective investors. The information helps investors analyze the impact on their investment return due to various prepayment assumptions and other issues affecting yield and flow of funds to the securities.

The yield and prepayment information includes detailed statistical and tabular data. Some of the common disclosure items include:

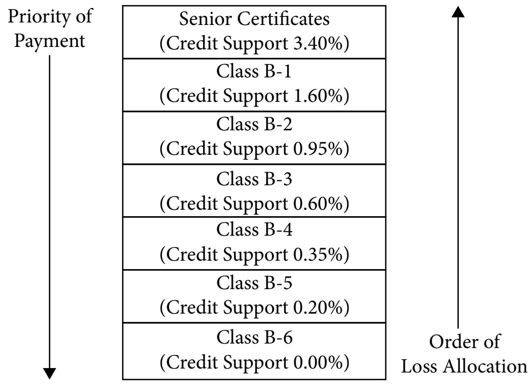
- percentage of the initial class balance outstanding at the end of each year;
- average life;
- yield;
- expected maturity;
- interest rate sensitivity;
- other information under specified prepayment, interest rate, loss, or related scenarios.

Many investors reverse-engineer and create their own model of the transaction. The model is used to perform analytics and computations using different assumptions.

Credit Support

Credit support for the Offered Certificates is provided by subordination as follows:

Subordination of Class B Certificates[1]



(1) The credit support percentage set forth in this chart shows the initial balance of the classes of Certificates subordinate to a class or classes as a percentage of the initial aggregate scheduled principal balance of the Mortgage Loans.

See "Description of the Certificates — Priority of Distributions" and "— Allocation of Losses" in this Prospectus Supplement.

After the Class B Certificates are no longer outstanding, any losses allocated to the Super Senior Certificates will be borne by the Super Senior Support Certificates, rather than the Super Senior Certificates, for so long as the Super Senior Support Certificates are outstanding.

Under certain circumstances, certain principal payments on the Mortgage Loans in a Loan Group otherwise distributable to the Class B Certificates may be allocated to the unrelated Group of Senior Certificates as discussed in "Description of the Certificates—Cross-Collateralization" in this Prospectus Supplement.

Shifting Interest in Prepayments

Additional credit enhancement is provided by the allocation of all principal prepayments on the Mortgage Loans in a Loan Group to the Class A Certificates of the related Group, subject to certain exceptions, for the first seven years and the disproportionately greater allocation of prepayments to such Class A Certificates over the following four years. The disproportionate allocation of prepayments on the Mortgage Loans in a Loan Group will accelerate the amortization of those Class A Certificates relative to the amortization of the Subordinate Certificates. As a result, the credit support percentage for the Class A Certificates of a Group should be maintained and may be increased during the first eleven years.

See "Description of the Certificates — Principal" in this Prospectus Supplement.

FIGURE 2.13 Credit enhancement features

Source: Banc of America Mortgage Securities, Inc. Mortgage Pass-Through Certificates, Series 2005-A, Prospectus filed pursuant to rule 424, available at the Securities and Exchange Commission website <http://www.sec.gov>, Central Index Key (CIK) number 0001315171

These computations supplement the computational materials provided by the underwriters and the disclosures included in the prospectus supplement. In order to validate the model, the investor compares their model output to the output in the prospectus supplement using the same inputs and assumptions.

Figure 2.14 provides the modeling assumptions for the sample transaction. The first assumption is the use of hypothetical mortgage loan data for each loan group. One preferred way to project the principal and interest cash flows for any pool of mortgages is to perform the cash flow projections on a loan-by-loan basis. Since the loan pool may contain hundreds or thousands of loans in a pool, it is often not practicable to model the cash flows for every loan in the pool. The issuer aggregates the actual loans into an illustrative or hypothetical groups or pool(s) which are representative of the entire loan pool. These hypothetical loan groups or "rep lines" are developed to approximate the estimated collateral cash flows of the entire pool. Modeling assumption (a) in Figure 2.14 shows 24 "rep lines" for the four collateral pools.

The second important modeling assumption is the prepayment model[26] and prepayment rate assumptions. The type of collateral securitized determines the appropriate prepayment model used by the issuer. Some transactions disclose a custom prepayment model.

Assumption (f) in Figure 2.14 indicates that the issuer is using the conditional prepayment rate (CPR) model. A prepayment assumption of 0% CPR assumes prepayment rates of 0% per annum; a prepayment assumption of 15% CPR assumes prepayment rates of 15% per annum of the remaining balance, and so forth. Rather than selecting a single prepayment rate, the issuer will often disclose the yield to maturity based on a range of prepayment rates. The range of prepayments will allow investors to determine the sensitivity of their yield to changes in the rate of prepayments.

Other assumptions related to the projection of collateral cash flows include:

- no net interest shortfalls, delinquencies, or realized losses;
- scheduled payments of principal and interest begin on February 1, 2005;
- any prepayments are received with 30 days' interest on the last day of each month beginning in January 2005;
- no optional termination of the Trust;
- no loans are required to be repurchased from the Trust;
- no loan substitutions;
- initial periodic caps of 2.00% to 5.00%;
- loans adjust annually on each anniversary of the first adjustment date;
- administrative fees or 0.2545% to 0.3795% per annum.

The final assumptions relate to the Certificates, which include:

- initial balances and passthrough rates for the Offered Certificates are as set forth beginning on page S-4;

[26] Prepayment modeling is covered in other chapters in this book.

Assumptions Relating to Tables

The tables beginning on page S-81 (the **"Decrement Tables"**) have been prepared on the basis of the following assumptions (the **"Modeling Assumptions"**):

(a) each Loan Group consists of the hypothetical mortgage loans presented below having the following characteristics:

	Unpaid Principal Balance	Current Mortgage Interest Rate	Remaining Term (Months)	Age (Months)	Cross Margin	Rate Coding	Remaining Interest Only Term (Months)	Months to First Adjustment Date
Loan Group 1	$ 591,344.63	3.7500000000%	355	5	2.2500000000%	9.7500000000%	0	20
	$ 718,103.35	4.7500011106%	358	2	2.2500000000%	10.7500011106%	0	34
	$ 26,070,106.79	4.6769350578%	359	1	2.2500000000%	10.6769350578%	0	35
	$ 16,892,476.00	5.0645759686%	360	0	2.2500000000%	11.0645759686%	0	36
	$ 351,679.52	4.5000000000%	358	2	2.2500000000%	10.5000000000%	34	34
	$ 35,781,019.95	4.7446100779%	359	1	2.2500000000%	10.7446100779%	35	35
	$ 22,202,080.00	4.8651316678%	360	0	2.2500000000%	10.8651316678%	36	36
Loan Group 2	$ 450,212.02	5.0000000000%	356	4	2.2500000000%	10.0000000000%	0	34
	$ 395,338.90	4.7500000000%	356	4	2.2500000000%	9.7500000000%	0	46
	$ 359,452.17	5.1250000000%	358	2	2.2500000000%	10.1250000000%	0	58
	$ 71,520,883.73	4.8375725491%	355	1	2.2500000000%	9.8375725491%	0	59
	$ 83,040,531.62	4.8743822439%	357	0	2.2500000000%	9.8743822439%	0	60
	$ 408,000.00	5.2500000000%	356	4	2.2500000000%	10.2500000000%	56	56
	$ 109,353,526.97	4.9580277894%	359	1	2.2500000000%	9.9580277894%	59	59
	$ 134,832,111.63	4.9581498637%	360	0	2.2500000000%	9.9581498637%	60	60
Loan Group 3	$ 410,993.29	5.6250000000%	358	2	2.2500000000%	10.6250000000%	0	70
	$ 11,026,113.97	5.2227702382%	359	1	2.2500000000%	10.2227702382%	0	83
	$ 7,410,775.00	5.2211975131%	360	0	2.2500000000%	10.2211975131%	0	84
	$ 11,250,102.00	5.1955489826%	359	1	2.2500000000%	10.1955489826%	83	83
	$ 9,716,050.00	5.6102981664%	360	0	2.2500000000%	10.6102981664%	84	84
Loan Group 4	$ 8,582,452.74	5.2909776151%	359	1	2.2500000000%	10.2909776151%	0	119
	$ 7,845,379.00	5.3564639611%	360	0	2.2500000000%	10.3564639611%	0	120
	$ 18,675,261.70	5.6000867373%	359	1	2.2500000000%	10.6000867373%	119	119
	$ 9,983,991.00	5.6815609484%	360	0	2.2500000000%	10.6815609484%	120	120

(b) the initial balances and pass-through rates for the Offered Certificates are as set forth or described in the table beginning on page S-4;

(c) there are no Net Interest Shortfalls, delinquencies or Realized Losses with respect to the Mortgage Loans;

(d) scheduled payments of principal and interest with respect to the Mortgage Loans are received on the applicable due date beginning on February 1, 2005;

(e) prepayments are received, together with 30 days' interest thereon, on the last day of each month beginning in January 2005;

(f) the Mortgage Loans prepay at the indicated percentages of CPR;

(g) optional termination of the Trust does not occur;

(h) no Mortgage Loans are required to be repurchased from the Trust and no Mortgage Loans are substitued foı the Mortgage Loans included in the Trust on the Closing Date;

(i) the Certificates are issued on the Closing Date;

FIGURE 2.14 Modeling assumptions

Source: Banc of America Mortgage Securities, Inc. Mortgage Pass-Through Certificates, Series 2005-A, Prospectus filed pursuant to rule 424, available at the Securities and Exchange Commission website <http://www.sec.gov>, Central Index Key (CIK) number 0001315171

- cash payments on the Certificates are received on the 25th day of each month beginning in February 2005 in accordance with the priorities and amounts described in this prospectus supplement under "Description of the Certificates";
- interest index remains constant at 3.16% per annum;
- Offered Certificates are issued on the Closing Date.

Based upon the modeling assumptions, the issuer prepares and discloses decrement tables that indicate the projected weighted-average life of each class of the Offered Certificates. The percentages of the initial class balance of each class that would be outstanding after each of the dates shown at various constant percentages of CPR is also disclosed. See Figure 2.15 for an example of a decrement table.

Percentage of Initial Class Balance Outstanding at the Respective Percentages of CPR Set Forth Below:

	Class 1-A-I							Class 1-A-R and Class 1-A-LR						
Distribution Date	**0%**	**15%**	**20%**	**25%**	**30%**	**40%**	**50%**	**0%**	**15%**	**20%**	**25%**	**30%**	**40%**	**50%**
Initial Percentage	100	100	100	100	100	100	100	100	100	100	100	100	100	100
January 25,2006	99	84	79	74	68	58	48	0	0	0	0	0	0	0
January 25,2007	99	70	62	54	47	34	23	0	0	0	0	0	0	0
January 25,2008	98	59	48	40	32	20	11	0	0	0	0	0	0	0
January 25,2009	96	49	38	29	22	12	5	0	0	0	0	0	0	0
January 25,2010	94	40	30	21	15	7	3	0	0	0	0	0	0	0
January 25,2011	93	34	23	16	10	4	1	0	0	0	0	0	0	0
January 25,2012	91	28	18	12	7	2	1	0	0	0	0	0	0	0
January 25,2013	89	23	14	9	5	1	*	0	0	0	0	0	0	0
January 25,2014	86	19	11	6	3	1	*	0	0	0	0	0	0	0
January 25,2015	84	16	9	5	2	*	*	0	0	0	0	0	0	0
January 25,2016	82	13	7	3	2	*	*	0	0	0	0	0	0	0
January 25,2017	79	11	5	2	1	*	*	0	0	0	0	0	0	0
January 25,2018	77	9	4	2	1	*	*	0	0	0	0	0	0	0
January 25,2019	74	7	3	1	*	*	*	0	0	0	0	0	0	0
January 25,2020	71	6	2	1	*	*	*	0	0	0	0	0	0	0
January 25,2021	68	5	2	1	*	*	*	0	0	0	0	0	0	0
January 25,2022	64	4	1	*	*	*	*	0	0	0	0	0	0	0
January 25,2023	61	3	1	*	*	*	*	0	0	0	0	0	0	0
January 25,2024	57	3	1	*	*	*	*	0	0	0	0	0	0	0
January 25,2025	53	2	1	*	*	*	*	0	0	0	0	0	0	0
January 25,2026	49	2	*	*	*	*	*	0	0	0	0	0	0	0
January 25,2027	45	1	*	*	*	*	*	0	0	0	0	0	0	0
January 25,2028	40	1	*	*	*	*	*	0	0	0	0	0	0	0
January 25,2029	35	1	*	*	*	*	*	0	0	0	0	0	0	0
January 25,2030	30	*	*	*	*	*	*	0	0	0	0	0	0	0
January 25,2031	24	*	*	*	*	*	*	0	0	0	0	0	0	0
January 25,2032	19	*	*	*	*	*	*	0	0	0	0	0	0	0
January 25,2033	13	*	*	*	*	*	*	0	0	0	0	0	0	0
January 25,2034	6	*	*	*	*	*	*	0	0	0	0	0	0	0
January 25,2035	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Weighted Average Life (in years)(1)	19.28	5.43	4.13	3.27	2.67	1.89	1.40	0.08	0.08	0.08	0.08	0.08	0.08	0.08

(1) The weighted average life of a class of Certificates is determined by (i) multiplying the amount of each distribution in reduction of the class balance thereof by the number of years from the date of the issuance of such class to the related Distribution Date, (ii) adding the results and (iii) dividing the sum by the initial class balance of that class.

* Less than 0.5%, but greater than zero.

FIGURE 2.15 Decrement table

Source: Banc of America Mortgage Securities, Inc. Mortgage Pass-Through Certificates, Series 2005-A, Prospectus filed pursuant to rule 424, available at the Securities and Exchange Commission website <http://www.sec.gov>, Central Index Key (CIK) number 0001315171

Yield Considerations with Respect to the Class B-2 and Class B-3 Cerificates

Defaults on mortgage loans may be measured relative to a default standard or model. The model used in this Prospectus Supplement, the standard default assumption **("SDA")**, represents an assumed rate of default each month relative to the outstanding performing principal balance of a pool of new mortgage loans. A default assumption of 100% SDA assumes constant default rates of 0.02% per annum of the outstanding principal balance of such mortgage loans in the first month of the life of the mortgage loans and an additional 0.02% per annum in each month thereafter until the 30th month. Beginning in the 30th month and in each month thereafter through the 60th month of the life of the mortgage loans, 100% SDA assumes a constant default rate of 0.60% per annum each month. Beginning in the 61st month and in each month thereafter through the 120th month of the life of the mortgage loans, 100% SDA assumes that the constant default rate declines each month by 0.0095% per annum, and that the constant default rate remains at 0.03% per annum in each month after the 120th month. For the following tables, it is assumed that there is no delay between the default and liquidation of the mortgage loans. As used in the following tables, "0% SDA" assumes no defaults. SDA is not a historical description of default experience or a prediction of the rate of default of any pool of mortgage loans.

FIGURE 2.16 Default model

Source: Banc of America Mortgage Securities, Inc. Mortgage Pass-Through Certificates, Series 2005-A, Prospectus filed pursuant to rule 424, available at the Securities and Exchange Commission website <http://www.sec.gov>, Central Index Key (CIK) number 0001315171

In order to illustrate loss sensitivity, the issuer prepares and discloses tables that present the sensitivity of the pre-tax yield to maturity on certain Certificates to various assumed rates of prepayment and varying assumed levels of realized losses. The tables are based upon the same modeling assumptions discussed, with two additional assumptions.

The first additional assumption is the default model, which describes the assumed rate of defaults each month relative to the outstanding principal balance of the pool of mortgages. Figure 2.16 provides a detailed description of the assumed Standard Default Assumption (SDA). The issuer discloses a loss severity assumption which indicates the amount of realized loss that will occur at the time of liquidation relative to the outstanding principal balance of the defaulted loans.

The second additional assumption is the purchase price of the certificate (expressed as a percentage of their initial class balance plus accrued interest). Figure 2.17 shows the resulting "yield sensitivity" tables.

Risk Factors

Many risk factors are common to ABS transactions. Each transaction should disclose a specific discussion of applicable risks. Issuers should explain how each risk may affect investors' return or yield.

Risk factors may be associated with the asset pool, the structure of the securities, the parties to the transaction, industry-specific risks, or general economic conditions. In

Sensitivity of Pre-Tax Yields to Maturity of the Class B-2 Certificates to Prepayments and Realized Losses

Percentage of SDA	Loss Severity Percentage	Percentage of CPR						
		0%	15%	20%	25%	30%	40%	50%
0%	0%	5.20%	5.20%	5.22%	5.25%	5.28%	5.37%	5.48%
50%	25%	5.20	5.20	5.22	5.25	5.28	5.37	5.48
50%	50%	4.75	5.20	5.22	5.25	5.28	5.37	5.48
75%	25%	5.20	5.20	5.22	5.25	5.28	5.37	5.49
75%	50%	(5.45)	5.20	5.21	5.25	5.28	5.37	5.49
100%	25%	4.82	5.20	5.22	5.25	5.28	5.37	5.49
100%	50%	(30.82)	4.81	5.21	5.24	5.28	5.37	5.49
150%	25%	(4.30)	5.20	5.22	5.25	5.28	5.37	5.49
150%	50%	(51.77)	(4.05)	1.12	4.46	5.28	5.37	5.49

FIGURE 2.17 Yield sensitivity

Source: Banc of America Mortgage Securities, Inc. Mortgage Pass-Through Certificates, Series 2005-A, Prospectus filed pursuant to rule 424, available at the Securities and Exchange Commission website <http://www.sec.gov>, Central Index Key (CIK) number 0001315171

our sample transaction, Figure 2.18 shows the disclosure of the first of a long list of risk factors.

Risk factors include:

- rate of principal payments on the Mortgage Loans will affect the yield on the Offered Certificates;
- there is a risk that interest payments on the Mortgage Loans may be insufficient to pay interest on your Certificates;
- variable rate of interest on the Offered Certificates will affect your yield;
- Mortgage Loans paying Interest Only until first adjustment date may have higher risk of default or rates of prepayment;
- Certificates may not be appropriate for individual investors;
- subordination of Super Senior Support Certificates and Class B Certificates increases risk of loss;
- Class B Certificates provide subordination for all groups;
- limited source of payments—no recourse to depositor, seller, servicer, or trustee;
- limited liquidity;
- geographic concentration may increase risk of loss due to adverse economic conditions or natural disasters;
- rights of beneficial owners may be limited by book-entry system;
- tax consequences of residual Certificates;
- United States military operations may increase risk of Relief Act shortfalls.

Post financial crisis, the risk disclosures included in a prospectus supplement have evolved to include significantly more disclosures surrounding the risks of the transaction

RISK FACTORS

- The Offered Certificates are not suitable investments for all investors.
- The Offered Certificates are complex financial instruments, so you should not purchase any Offered Certificates unless you or your financial advisor possess the necessary expertise to analyze the potential risks associated with an investment in mortgage-backed securities.
- You should not purchase any Offered Certificates unless you understand, and are able to bear, the prepayment, credit, liquidity and market risks associated with those Offered Certificates.
- You should carefully consider the risk factors discussed below in addition to the other information contained in this Prospectus Supplement and the Prospectus.

The Rate of Principal Payments on the Mortgage Loans Will Affect the Yield on the Offered Certificates

The rate of distributions of principal and the yield to maturity on your Certificates will be directly related to (i) the rate of payments of prinicipal on the applicable Mortgage Loans and (ii) the amount and timing of defaults by borrowers that result in losses on such Mortgage Loans. Borrowers are permitted to prepay their Mortgage Loans, in whole or in part, at any time.

The rate of principal payments on the Mortgage Loans mainly will be affected by the following:

- the amortization schedules of the Mortgage Loans;
- the rate of partial prepayments and full prepayments by borrowers due to refinancing, job transfer, changes in property values or other factors;
- liquidations of the properties that secure defaulted Mortgage Loans;
- repurchases of Mortgage Loans by the Depositor as a result of defective documentation or breaches of representations or warranties or as the result of the conversion of a Mortgage Loan from an adjustable to a fixed interest rate;
- purchases by the Depositor of certain delinquent Mortgage Loans; and
- the optional repurchase of all the Mortgage Loans by the Depositor under the circumstances described under "The Pooling and Servicing Agreement—Optional Termination" to effect a termination of the trust.

For a more detailed discussion of these factors, see "The Pooling and Servicing Agreement — Repurchases of Mortgage Loans," "— Optional Repurchases of Certain Mortgage Loans" and "— Optional Termination" and " Prepayment and Yield Considerations" in this Prospectus Supplement and "The Pooling and Servicing Agreement — Assignment of Mortgage Loans to the Trustee" and "— Termination; Optional Purchase of Mortgage Loans" and "Prepayment and Yield Considerations" in the Prospectus.

FIGURE 2.18 Risk factors

Source: Banc of America Mortgage Securities, Inc. Mortgage Pass-Through Certificates, Series 2005-A, Prospectus filed pursuant to rule 424, available at the Securities and Exchange Commission website <http://www.sec.gov>, Central Index Key (CIK) number 0001315171

parties, including bankruptcy or insolvency of the transferor and servicer. Additionally, issuers are including significantly more disclosures surrounding the macroeconomic factors that could affect investor returns such as:[27]

- turbulence in the financial markets and economy may adversely affect the performance and market value of your Certificates and these conditions may not improve in the near future;
- recent trends in the residential mortgage market may adversely affect the performance and market value of your Certificates;
- governmental actions may affect servicing of Mortgage Loans and may limit the servicers' ability to foreclose;
- mortgage loan modification programs and future legislative action may adversely affect the performance and market value of your Certificates.

Typical Sections of a Prospectus and Prospectus Supplement (Agency)

In the sections that follow, we will examine a sample of the types of information that is of most interest to prospective investors in the agency- or government-issued MBS market. We will use an example of a Fannie Mae residential MBS to walk through the critical sections of the offering documents.[28]

An agency securitization offering document discloses the collateral, bond, and deal-specific information. The disclosure documents for any particular series of certificates issued by Fannie Mae include the base prospectus and the related prospectus supplement. The base prospectus contains general information including:

- information about the issue and the guarantor;
- risk factors associated with an investment in the certificates;
- description of the certificates;
- yield, maturity, and prepayment considerations;
- class definitions.

The prospectus supplement contains information that is specific to a particular trust and supplements the disclosures in the base prospectus. The prospectus supplement

[27] Prospectus Supplement dated May 22, 2013 to Prospectus dated April 24, 2013 of SEQUOIA MORTGAGE TRUST 2013-7, Mortgage Pass-Through Certificates, Series 2013-7.

[28] The material in this section is referenced from the Fannie Mae website <http://www.fanniemae.com/portal/index.html> and Fannie Mae base prospectus<http://www.fanniemae.com/portal/jsp/mbs/documents/remic/prospectus/index.html>.

should be read in conjunction with the applicable disclosure documents referred to, therein, including the base prospectus.

Cover and Summary of Terms

Disclosures on the cover page of an agency prospectus supplement are generally limited and similar to a private-label MBS issuance. The information provides a summary of the issuer, the type of collateral, the offered securities, and some class-specific data.

A quick glance at Figure 2.19, the cover page of the prospectus supplement, will allow the investor to identify several important pieces of information such as:

- Fannie Mae is issuing and servicing $676,404,619 of residential first lien, fixed-rate, and adjustable-rate single-family mortgage loans, substantially.
- There are six collateral groups.
- There will be 20 classes of certificates offered by one underwriter.
- Fannie Mae guarantees the required payments of principal and interest on the certificates.
- The certificates are not guaranteed by the United States.
- The certificates have an anticipated settlement date of February 27, 2015.
- This document is a prospectus supplement and it should be read in conjunction with the base prospectus.
- The certificates are exempt from registration under the Securities Act of 1933 and are "exempted securities" under the Securities Exchange Act of 1934.

Figure 2.19 also provides the investor with class-specific information about the certificates. The investors are presented with the summary description of the principal type and interest type, class balance and interest rate, CUSIP information, and the final distribution date of the certificates. Footnotes 2 through 5 in Figure 2.19 describe how the interest rate will be calculated on certain classes and which securities are exchangeable classes.[29] A full description of the principal and interest types is disclosed in the base prospectus.

For example, the interest type associated with the SA Class is "WAC/IO." WAC is described in the base prospectus as "Weighted Average Coupon—Has an interest rate that represents an effective weighted average interest rate that may change from period to period. A Weighted Average Coupon Class may consist of components, some of which have different interest rates."

IO is described in the base prospectus as "Interest Only—Receives some or all of the interest payments made on the related series trust assets but no principal. Interest Only Classes have a notional principal balance. A notional principal balance is the amount

[29] Exchangeable classes are certain bonds that are noted as "exchangeable" and can be voluntarily exchanged for a proportionate interest in a related RCR certificate as shown in a schedule that is disclosed within the prospectus supplement.

Prospectus Supplement
(To REMIC Prospectus dated June 1, 2014)

$676,404,619

FannieMae®

Guaranteed REMIC Pass-Through Certificates
Fannie Mae REMIC Trust 2015–10

The Certificates

We, the Federal National Mortgage Association (Fannie Mae), will issue the classes of certificates listed in the chart on this cover.

Payments to Certificateholders

We will make monthly payments on the certificates. You, the investor, will receive

- interest accrued on the balance of your certificate (except in the case of the accrual classes), and
- principal to the extent available for payment on your class.

We will pay principal at rates that may vary from time to time. We may not pay principal to certain classes for long periods of time.

The Fannie Mae Guaranty

We will guarantee that required payments of principal and interest on the certificates are available for distribution to investors on time.

The Trust and its Assests

The trust will own

- Fannie Mae MBS backed by first lien, single-family fixed-rate loans,
- underlying REMIC certificates backed by Fannie Mae MBS, and
- Fannie Mae MBS backed by first lien, single-family adjustable-rate loans.

The mortgage loans backing the underlying REMIC certificates are first lien, single-family, fixed-rate loans.

Class	Group	Original Class Balance	Principal Type(1)	Interest Rate	Interest Type(1)	CUSIP Number	Final Distribution Date
AP	1	$ 30,000,000	PAC/AD	2.75%	FIX	3136AMZK8	March 2045
GP	1	29,831,000	PAC/AD	2.50	FIX	3136AMZL6	March 2045
PC	1	31,174,000	PAC/AD	3.50	FIX	3136AMZM4	July 2044
PE	1	1,574,000	PAC/AD	3.50	FIX	3136AMZN2	March 2045
PI	1	14,951,714(2)	NTL	3.50	FIX/IO	3136AMZP7	March 2045
UZ	1	26,768,135	SUP	3.50	FIX/Z	3136AMZQ5	March 2045
AI	2	56,511,895(2)	NTL	3.50	FIX/IO	3136AMZR3	August 2043
FA	3	137,897,672	PT	(3)	FLT/AFC	3136AMZS1	March 2045
SA	3	137,897,672(2)	NTL	(4)	WAC/IO	3136AMZT9	March 2045
CA	4	24,940,000	SEQ	4.00	FIX	3136AMZU6	February 2044
CB	4	2,224,917	SEQ	4.00	FIX	3136AMZV4	March 2045
BA	5	140,484,000	PAC/AD	3.50	FIX	3136AMZW2	October 2044
BZ(5)	5	1,631,000	PAC/AD	3.50	FIX/Z	3136AMZX0	March 2045
Z(5)........	5	25,829,476	SUP	3.50	FIX/Z	3136AMZY8	March 2045
KA(5).....	6	161,014,000	SEQ	3.00	FIX	3136AMZZ5	July 2040
AV(5).....	6	14,297,000	SEQ/AD	3.00	FIX	3136AMA25	May 2026
BV(5).....	6	12,550,000	SEQ/AD	3.00	FIX	3136AMA33	October 2033
KZ(5).....	6	36,189,419	SEQ	3.00	FIX/Z	3136AMA41	March 2045
R		0	NPR	0	NPR	3136AMA58	March 2045
RL		0	NPR	0	NPR	3136AMA66	March 2045

(1) See "Description of the Certificates—Class Definitions and Abbreviations" in the REMIC prospectus.
(2) Notional principal balances. These classes are interest only classes. See page S-6 for a description of how their notional principal balances are calculated.
(3) Based on LIBOR and subject to the limitations described on page S-13.
(4) The interest rate of the SA Class is calculated as described on pages S-13 and S-14.
(5) Exchangeable classes.

If you own certificates of certain classes, you can exchange them for certificates of the corresponding RCR classes to be delivered at the time of exchange. The MZ, KB, KI, KC and KT Classes are the RCR classes. For a more detailed description of the RCR classes, see Schedule 1 attached to this prospectus supplement and "Description of the Certificates—Combination and Recombination—RCR Certificates" in the REMIC prospectus.

The dealer will offer the certificates from time to time in negotiated transactions at varying prices. We expect the settlement date to be February 27, 2015.

Carefully consider the risk factors on page S-8 of this prospectus supplement and starting on page 14 of the REMIC prospectus. Unless you understand and are able to tolerate thses risks, you should not invest in the certificates.

You should read the REMIC prospectus as well as this prospectus supplement.

The certificates, together with interest thereon, are not guaranteed by the United States and do not constitute a debt or obligation of the United States or any agency or instrumentality thereof other than Fannie Mae.

The certificates are exempt from registration under the Securities Act of 1933 and are "exempted securities" under the Securities Exchange Act of 1934.

Barclays

The date of this Prospectus Supplement is February 23, 2015

FIGURE 2.19 Cover page (agency)

Source: Fannie Mae Guaranteed REMIC Pass-Through Certificates, Fannie Mae REMIC Trust 2015–10 as published on the Fannie Mae REMIC Prospectus Supplement website, <http://www.fanniemae.com/portal/jsp/mbs/documents/remic/remicprospectussupplements.html>

used as a reference to calculate the amount of interest due on an Interest Only Class." Continuing with our example of the SA Class, Figure 2.20 shows that the SA Class is 100% notional to the FA Class which means that the notional principal balance of the SA Class will be equal to 100% of the outstanding balance of the FA Class on each Distribution Date.

Each group number represents a pool of mortgages with specific characteristics. In our example, there are six groups as noted on the cover page of the prospectus supplement.

The class nomenclature is generally designed to provide investors with guidance about the security. In our example, class names that have a "Z" represent Accrual Classes. Classes that include the letter "I" generally represent Interest-Only Classes.

The final Distribution Date represents the date on which the distribution of principal of each class would cause the outstanding principal balance for that class to be zero after such distribution.

Investors are cautioned to examine the full description of the securities presented in the prospectus and prospectus supplement when assessing and evaluating class characteristics.

Asset Pool Information

Given the credit guaranty, asset pool disclosure for an agency MBS issuance is limited when compared to a private-label MBS issuance. Only key information about the composition and characteristics of the asset pool is disclosed to an investor for an agency MBS issuance.

Figure 2.21 provides an example of the asset pool disclosures that are typical for an agency MBS. The typical categories of disclosure for agency MBS include:

- principal balance of the pool of assets;
- passthrough rate of the pool of assets;
- range of weighted-average coupons of the pool of assets;
- range of weighted-average remaining terms to maturity of the pool of assets;
- original term to maturity of the underlying mortgage loans;
- remaining term to maturity of the underlying mortgage loans;
- loan age of the underlying mortgage loans;
- interest rate of the underlying mortgage loans.

In addition to the pool information, Figures 2.22 and 2.23 indicate the certificates have three types of collateral, the fixed-rate MBS, the Group 2 underlying REMIC certificates, and the ARM (adjustable-rate mortgage) MBS. Disclosures also include specific characteristics of the underlying loans, such as jumbo conforming loans or high balance loans.[30]

[30] A high balance loan is a loan where the balance exceeds Fannie Mae's conforming loan limit.

Notional Classes

The notional principal balances of the notional classes specified below will equal the percentages of the outstanding balances specified below immediately before the related distribution date:

Class	
PI	49.8390466667% of the AP Class
AI	100% of the aggregate notional principal balance of the Group 2 Underlying REMIC Certificates
SA	100% of the FA Class
KI	33.3333331263% of the KA Class

Weighted Average Lives (years)*

Group 1 Classes	PSA Prepayment Assumption 0%	100%	150%	180%	350%	700%	1100%
AP, GP and PI	12.8	6.4	5.6	5.6	5.6	3.3	2.4
PC	12.3	5.9	5.0	5.0	5.0	3.1	2.2
PE	21.5	17.0	17.0	17.0	17.0	8.8	5.3
UZ	26.2	19.4	16.5	15.1	2.5	1.2	0.9

Group 2 Class	PSA Prepayment Assumption 0%	100%	200%	350%	700%	1100%
AI	13.3	5.6	5.1	3.8	1.9	1.1

Group 3 Classes	PSA Prepayment Assumption 0%	100%	200%	400%	800%	1200%
FA and SA	12.9	8.3	5.8	3.3	1.5	0.8

Group 4 Classes	PSA Prepayment Assumption 0%	100%	200%	400%	800%	1200%
CA	18.7	7.9	5.0	2.6	1.2	0.6
CB	29.5	22.4	18.5	11.3	5.2	2.7

Group 5 Classes	PSA Prepayment Assumption 0%	100%	170%	225%	270%	400%	700%	1100%
BA	14.3	6.5	5.4	5.4	5.4	3.9	2.3	1.4
BZ	24.2	21.8	21.8	21.8	21.8	16.8	9.7	5.4
Z	27.3	19.9	16.0	7.3	2.0	0.8	0.4	0.2
MZ	27.1	20.1	16.8	8.8	4.1	2.3	1.1	0.6

Group 6 Classes	PSA Prepayment Assumption 0%	100%	150%	300%	500%
KA, KB, KC and KI	15.5	5.7	4.3	2.4	1.4
AV	5.9	5.9	5.9	4.6	3.1
BV	15.0	13.5	11.1	6.7	4.2
KZ	27.8	20.0	17.3	11.3	7.1
KT	19.0	9.5	7.6	4.5	2.7

* Determined as specified under "Yield, Maturity and Prepayment Considerations—Weighted Average Lives and Final Distribution Dates" in the REMIC Prospectus.

FIGURE 2.20 Notional classes (agency)

Source: Fannie Mae Guaranteed REMIC Pass-Through Certificates, Fannie Mae REMIC Trust 2015–10 as published on the Fannie Mae REMIC Prospectus Supplement website, <http://www.fanniemae.com/portal/jsp/mbs/documents/remic/remicprospectussupplements.html>

SUMMARY

This summary contains only limited information about the certificates. Statistical information in this summary is provided as of February 1, 2015. You should purchase the certificates only after reading this prospectus supplement and each of the additional disclosure documents listed on page S-3. In particular, please see the discussion of risk factors that appears in each of those additional disclosure documents.

Assets Underlying Each Group of Classes

Group	Assets
1	Group 1 MBS
2	Class 2014-54-IN REMIC Certificate
	Class 2015-3-AI REMIC Certificate
3	Group 3 MBS
4	Group 4 MBS
5	Group 5 MBS
6	Group 6 MBS

Group 1, Group 4, Group 5 and Group 6

Characteristics of the Fixed Rate MBS

	Approximate Principal Balance	Pass-Through Rate	Range of Weighted Average Coupons or WACs (annual percentages)	Range of Weighted Average Remaining Terms to Maturity or WAMs (in months)
Group 1 MBS	$119,347,135	3.50%	3.75% to 6.00%	241 to 360
Group 4 MBS	$ 27,164,917	4.00%	4.25% to 6.50%	241 to 360
Group 5 MBS	$167,944,476	3.50%	3.75% to 6.00%	241 to 360
Group 6 MBS	$224,050,419	3.00%	3.25% to 5.50%	241 to 360

Assumed Characteristics of the Underlying Mortgage Loans

	Principal Balance	Original Term to Maturity (in months)	Remaining Term to Maturity (in months)	Loan Age (in months)	Interest Rate
Group 1 MBS	$119,347,135	360	358	1	4.240%
Group 4 MBS	$ 27,164,917	360	299	53	4.568%
Group 5 MBS	$167,944,476	360	340	16	4.183%
Group 6 MBS	$224,050,419	360	334	23	3.629%

The actual remaining terms to maturity, loan ages and interest rates of most of the mortgage loans underlying the fixed rate MBS will differ from those shown above, and may differ significantly. See "Risk Factors—Risks Relating to Yield and Prepayment—*Yields on and weighted average lives of the certificates are affected by actual characteristics of the mortgage loans backing the series trust assets*" in the REMIC Prospectus.

FIGURE 2.21 Asset pool disclosure (agency)

Source: Fannie Mae Guaranteed REMIC Pass-Through Certificates, Fannie Mae REMIC Trust 2015–10 as published on the Fannie Mae REMIC Prospectus Supplement website, <http://www.fanniemae.com/portal/jsp/mbs/documents/remic/remicprospectussupplements.html>

DESCRIPTION OF THE CERTIFICATES

The material under this heading describes the principal features of the Certificates. You will find additional information about the Certificates in the other sections of this prospectus supplement, as well as in the additional Disclosure Documents and the Trust Agreement. If we use a capitalized term in this prospectus supplement without defining it, you will find the definition of that term in the applicable Disclosure Document or in the Trust Agreement.

General

Structure. We will create the Fannie Mae REMIC Trust specified on the cover of this prospectus supplement (the "Trust") pursuant to a trust agreement dated as of May 1, 2010 and a supplement thereto dated as of February 1, 2015 (the "Issue Date"). We will issue the Guaranteed REMIC Pass-Through Certificates (the "REMIC Certificates") pursuant to that trust agreement and supplement. We will issue the Combinable and Recombinable REMIC Certificates (the "RCR Certificates" and, together with the REMIC Certificates, the "Certificates") pursuant to a separate trust agreement dated as of May 1, 2010 and a supplement thereto dated as of the Issue Date (together with the trust agreement and supplement relating to the REMIC Certificates, the "Trust Agreement"). We will execute the Trust Agreement in our corporate capacity and as trustee (the "Trustee"). In general, the term "Classes" includes the Classes of REMIC Certificates and RCR Certificates.

The assets of the Trust will include:

- four groups of Fannie Mae Guaranteed Mortgage Pass-Through Certificates having fixed pass-through rates (the "Group 1 MBS," "Group 4 MBS," "Group 5 MBS" and "Group 6 MBS," and together, the "Fixed Rate MBS"),
- one group of previously issued REMIC Certificates (the "Group 2 Underlying REMIC Certificates") issued from the related Fannie Mae REMIC trusts (the "Underlying REMIC Trusts"), as further described in Exhibit A-1, and
- one group of Fannie Mae Guaranteed Mortgage Pass-Through Certificates having variable pass-through rates (the "Group 3 MBS" or "ARM MBS").

The Fixed Rate MBS

The Fixed Rate MBS provide that principal and interest on the related Mortgage Loans are passed through monthly. The Mortgage Loans underlying the Fixed Rate MBS are conventional, fixed-rate, fully-amortizing mortgage loans secured by first mortgages or deeds of trust on single-family residential properties. These Mortgage Loans have original maturities of up to 30 years.

In addition, the pools of mortgage loans backing the Group 1 MBS and the Group 5 MBS have been designated as pools that include "jumbo-conforming" or "high balance" mortgage loans as described further under "The Mortgage Loans—Special Feature Mortgage Loans—*Mortgage Loans with Original Principal Balances Exceeding our Traditional Conforming Loan Limits*" in the MBS Prospectus dated October 1, 2014. For periodic updates to that description, please refer to the Pool Prefix Glossary available on our Web site at www.fanniemae.com. For additional information about the particular pools underlying the Group 1 MBS and the Group 5 MBS, see the Final Data Statement for the Trust and the related prospectus supplement for each MBS. See also "Risk Factors—Risks Relating to Yield and Prepayment—Refinancing of Loans; Sale of Property—"*Jumbo-conforming" mortgage loans, which have original principal balances that exceed our traditional conforming loan limits, may prepay at different rates than conforming balance mortgage loans generally*" in the MBS Prospectus dated October 1, 2014.

For additional information, see "Summary—Group 1, Group 4, Group 5 and Group 6—Characteristics of the Fixed Rate MBS" in this prospectus supplement and "The Mortgage Loan Pools" and Yield, Maturity and Prepayment considerations" in the MBS Prospectus.

FIGURE 2.22 Description of the Certificates (agency)

Source: Fannie Mae Guaranteed REMIC Pass-Through Certificates, Fannie Mae REMIC Trust 2015–10 as published on the Fannie Mae REMIC Prospectus Supplement website, <http://www.fanniemae.com/portal/jsp/mbs/documents/remic/remicprospectussupplements.html>

The Group 2 Underlying REMIC Certificates

The Group 2 Underlying REMIC Certificates represent beneficial ownership interest in the related Underlying REMIC Trusts. The assets of those trusts consist of MBS (or beneficial ownership interests in MBS) having the general characteristics set forth in the MBS Prospectus. Each MBS evidences beneficial ownership interests in a pool of conventional, fixed-rate, fully-amortizing mortgage loans secured by first mortgages or deeds of trust on single-family residential properties, as described under "The Mortgage Loan Pools" and "Yield, Maturity and Prepayment Considerations" in the MBS Prospectus.

In addition, the pools of Mortgage Loans backing the Group 2 Underlying REMIC Certificates have been designated as pools that include "jumbo-conforming" or "high balance" mortgage loans as described further under "The Mortgage Loans—Special Feature Mortgage Loans—*Mortgage Loans with Original Principal Balances Exceeding our Traditional Conforming Loan Limits*" in the MBS Prospectus dated October 1, 2014. For periodic updates to that description, please refer to the Pool Prefix Glossary available on our Web site at www.fanniemae.com. For additional information about the particular pools backing the Group 2 Underlying REMIC Certificates, see the Final Data Statements for the related trusts and the related prospectus supplement for each MBS. See also "Risk Factors—Risks Relating to Yield and Prepayment—Refinancing of Loans; Sale of Property—"*Jumbo-conforming*" *mortgage loans, which have original principal balances that exceed our traditional conforming loan limits, may prepay at different rates than conforming balance mortgage loans generally*" in the MBS Prospectus dated October 1, 2014.

Distributions on the Group 2 Underlying REMIC Certificates will be passed through monthly, beginning in the month after we issue the Certificates. The general characteristics of the Group 2 Underlying REMIC Certificates are described in the related Underlying REMIC Disclosure Documents. See Exhibit A-1 for certain additional information about the Group 2 Underlying REMIC Certificates. Exhibit A-1 is provided in lieu of a Final Data Statement with respect to the Group 2 Underlying REMIC Certificates.

The ARM MBS

Unless otherwise specified, references in this section to percentages of the Hybrid ARM Loans are in each case measured by aggregate principal balance of the Hybrid ARM Loans at the Issue Date.

General

The Mortgage Loans underlying the ARM MBS in Group 3 (the "Hybrid ARM Loans") will have the general characterists described in the MBS Prospectus. In addition, we assume that the Hybrid ARM Loans will have the characteristics listed in the first table on Exhibit A-2 to this prospectus supplement. The ARM MBS provide that principal and interest on the Hybrid ARM Loans are passed through monthly, beginning in the month after we issue the ARM MBS. The Hybrid ARM Loans are conventional, adjustable-rate mortgage loans secured by first mortgages or deeds of trust on single-family residential properties. The Hybrid ARM Loans have original maturities of up to 30 years. See "Description of the Certificates," "The Mortgage Loan Pools, " "The Mortgage Loans—Adjustable-Rate Mortgage Loans (ARM Loans)" and "Yield, Maturity and Prepayment Considerations" in the MBS Prospectus. See also the second table in Exhibit A-2 to this prospectus supplement for the pool numbers of the ARM MBS expected to be included in the Lower Tier REMIC.

FIGURE 2.23 Underlying asset disclosures (agency)

Source: Fannie Mae Guaranteed REMIC Pass-Through Certificates, Fannie Mae REMIC Trust 2015–10 as published on the Fannie Mae REMIC Prospectus Supplement website, <http://www.fanniemae.com/portal/jsp/mbs/documents/remic/remicprospectussupplements.html>

Disclosures of the interest rate features on the underlying loans are typically included within the description of the certificates section of a prospectus supplement, including:

- applicable index at which the interest rate of the ARM loan will adjust;
- initial interest-only periods, initial fixed-rate periods, initial and subsequent cap and floor interest rates, lifetime cap and floor interest rates;
- servicing fees, prepayment premium periods, etc.

For those investors that choose to reverse-engineer[31] a transaction, the collateral pool data can be used to establish a range of prepayment assumptions.

Description of the Certificates

In an agency issuance, prepayment risk is generally considered the most significant risk. There are a number of principal and interest type designations which investors should consider in evaluating the impact of prepayments. The certificate type depends primarily on the priority of distribution among the bonds. These are usually described in the base prospectus and the prospectus supplement. The issuer must disclose the following certificate information:

- provisions with respect to maturity, conversion, redemption, amortization, or retirement;
- denominations and form;
- terms and conditions of book-entry securities;
- date and frequency of distributions;
- source of cash flow available for distribution;
- priority of distributions;
- method of calculating and distributing interest;
- method of calculating and distributing principal.

The description also includes the allocations of payments, and distribution priorities among all classes of securities. The description includes any requirements that direct or redirect cash flows to other securities, and a description of the purpose of those requirements.

The certificates generally represent beneficial ownership interests in a distinct pool of assets. In our example, Figure 2.22, we see that the certificates are backed by six groups of

[31] In general, reverse-engineering is to ascertain the functional basis of something by taking it apart and studying how it works. In the context of mortgage-backed securities, a reverse-engineering transaction refers to the process by which an investor or other party creates a mathematical model to calculate future payments of principal and interest to one or more of the securities in a transaction. In a two-step process, known information about the asset pool (balance, coupon, term) is combined with assumed information (prepayment speed, default, recovery, and interest rate information) to project collateral cash flows. The second step uses the collateral cash flows for each period to make projected class cash flows. These projected class cash flows serve as the basis for valuing the mortgage-backed security.

assets consisting of four fixed-rate MBS, one previously issued Fannie Mae certificate, and one ARM MBS. Each certificate has an interest type and a principal type.

If the certificates of a particular class are interest-bearing, they will accrue interest during the applicable interest accrual period at the applicable annual interest rate described in the prospectus supplement. If the interest rate is fixed for a particular class, the rate will be displayed on the cover of the prospectus supplement. If the interest rate is floating, the interest rate formula will be described in the prospectus supplement along with the initial rate.

If the certificate is an Accrual Class, the prospectus supplement will describe how and when the interest that accrues during an interest accrual period will be paid. For an Accrual Class, any accrued interest that is not to be paid on a Distribution Date will be added to the principal balance of each certificate of that class and, having been converted to principal, will accrue interest.[32]

In our example, Figure 2.24, Class UZ is an Accrual Class and the interest accrued on the UZ Class will be added to the principal balance of the UZ Class. The interest collection will be paid as principal to the different classes in the group as per the instructions in the prospectus supplement.

The prospectus supplement for each series of certificates will specify how the total principal payment amount is allocated among the classes of certificates of that series on each Distribution Date. In our example, Figure 2.25 describes the priority of principal payments in each group. In Group 1, the interest payments due on the UZ Class will be added to the outstanding balance of the UZ Class and will be paid as principal to the classes in Aggregate Group I on each Distribution Date. In Group 4, certificates are paid sequentially.

The prospectus supplement discloses when an early or accelerated amortization event may occur. If there are PAC or TAC classes involved in the structure, the prospectus supplement generally discloses the PAC structuring and effective ranges, or the TAC structuring and effective speed along with the principal balance schedules. This can be seen in Figures 2.26 and 2.27, respectively.

Other disclosures include the frequency of distributions and the distribution dates. Investors should understand the related collection periods for the pool assets, and how cash is collected, invested, and transferred to various parties to the trust.

The final piece of information regarding the transaction is the certification of any residual or retained interests to the cash flows. Investors should consider the disposition of all collateral cash flows, including excess cash flows not used to pay fees or to make payments to other certificate holders.

In our example, any excess cash flows are directed to the Class R and RL certificates. The issuer discloses in the base prospectus that:

> On each distribution date, we will pay to the holders of the "residual" certificates of a particular series the amount of principal and interest, if any, specified in the related prospectus supplement. In addition, we will pay to these holders the

[32] <http://www.fanniemae.com/syndicated/documents/mbs/remicpros/SF_FM_June_1_2014.pdf>.

Distributions of Interest

General. The Certificates will bear interest at the rates specified in this prospectus supplement. Interest to be paid on each Certificate (or added to principal, in the case of the Accrual Classes) on a Distribution Date will consist of one month's interest on the outstanding balance of that Certificate immediately prior to that Distribution Date. For a description of the Accrual Classes, see "*—Accrual Classes*" below.

The FA Class will bear interest at an interest rate based on LIBOR. We currently establish LIBOR on the basis of the "ICE Method" as generally described under "Description of the Certificates — Distributions on Certificates—*Interest Distributions—Indices for Floating Rate Classes*

Accrual Classes. The UZ, BZ, Z, KZ, and MZ Classes are Accrual Classes. Interest will accrue on each Accrual Class at the applicable annual rate specified on the cover of this prospectus supplement or on Schedule 1. However, we will not pay any interest on the Accrual Classes. Instead, interest accrued on each Accrual Class will be added as principal to its principal balance on each Distribution DAte. We will pay principal on the Accrual Classes as described under"—Distributions of Principal" below.

The FA Class.

On each Distribution Date,we will pay interest on the FA Class in an amount equal to one month's interest at an annual rate equal to the *lesser* of

- LIBOR + 35 basis points

  or

- the Weighted Average Group 3 MBS Pass -Through Rate (described below)

(but in no event less than 0%).

The "Weighted Average Group 3 MBS Pass-Through Rate" for any Distribution Date is equal to the weighted average of the passs-through rates of the Group 3 MBS in effect for calculating distributions on that Distribution Date, weighted on the basis of the principal balances of the Group 3 MBS after giving effect to distributions of principal made on the immediately preceding Distribution Date.

During the initial interest accrual period, the FA Class will bear interest at an annual rate of 0.5217%. Our determination of the interest rate for the FA Class will be final and binding in the absence of manifest error. You may obtain each such interest rate by telephoning us at 1-800-237-8627.

FIGURE 2.24 Accrual Class description (agency)

Source: Fannie Mae Guaranteed REMIC Pass-Through Certificates, Fannie Mae REMIC Trust 2015–10 as published on the Fannie Mae REMIC Prospectus Supplement website, <http://www.fanniemae.com/portal/jsp/mbs/documents/remic/remicprospectussupplements.html>

proceeds of any remaining assets of the related REMIC after the principal balances (or notional principal balances) of all the other classes of certificates have been reduced to zero.

Fees and Expenses

The agency prospectus and prospectus supplement contains limited information on fees and expenses. Agency transactions typically contain a trust servicing fee and a guaranty fee. In our example, Figure 2.21 disclosed that Group 1 MBS Pass-Through Rate is 3.50% and the Interest Rate on Group 1 MBS is 4.240%. This suggests that the trust expects to collect 4.240% of interest from the mortgage loans underlying Group 1 and expects to

Distributions of Prinicpal

On the Distribution Date in each month, we will make payments of principal on the Classes of REMIC Certificates as described below. Following any exchange of REMIC Certificates for RCR Certificates, we will apply principal payments from the exchanged REMIC Certificates to the corresponding RCR Certificates on a pro rata basis.

- *Group 1*

The UZ Accrual Amount to Aggregate Group I to its Planned Balance, and thereafter to UZ.

Accretion Directed FAC Group and Accrual Class

The Group 1 Cash Flow Distribution Amount in the following priority:

1. To Aggregate Group I to its Planned Balance. **FAC Group**
2. To UZ until retired. **Support Class**
3. To Aggregate Group I to zero. **FAC Group**

The "UZ Accrual Amount" is any interest then accrued and added to the principal balance of the UZ Class.

The "Group 1 Clash Flow Distribution Amount" is the principal then paid on the Group 1 MBS.

"Aggregate Group I" consists of the AP, GP, PC and PE Classes. On each Distribution Date, we will apply payments of principal of Aggregate Group I as follows:

—32.4047570183% to AP until retired,

—32.2222102205% to GP until retired, and

—35.3730327612% to PC and PE, in that order, until retired.

Aggregate Group I has a principal balance equal to the aggregate principal balance of the Classes included in Aggregate Group I.

- *Group 3*

The Group 3 Principal Distribution Amount to FA until retired. **Pass-Through Class**

The "Group 3 Principal Distribution Amount" is the principal then paid on the Group 3 MBS.

- *Group 4*

The Group 4 Prinicpal Distribution Amount to CA and CB, in that order, until retired. **Sequential Pay Classes**

The "Group 4 Principal Distribution Amount" is the principal then paid on the Group 4 MBS.

FIGURE 2.25 Distribution of principal

Source: Fannie Mae Guaranteed REMIC Pass-Through Certificates, Fannie Mae REMIC Trust 2015–10 as published on the Fannie Mae REMIC Prospectus Supplement website, <http://www.fanniemae.com/portal/jsp/mbs/documents/remic/remicprospectussupplements.html>

Principal Balance Schedules. The Principal Balance Schedules are set forth beginning on page B-1 of this prospectus supplement. The Principal Balance Schedules were prepared based on the Pricing Assumptions and the assumption that the related Mortgage Loans prepay at a constant rate within the applicable "Structuring Ranges" specified in the chart below. The "Effective Range" for an Aggregate Group is the range of prepayment rates (measured by *constant* PSA rates) that would reduce that Aggregate Group to its scheduled balance each month based on the Pricing Assumptions. We have not provided separate schedules for the individual Classes included in the Aggregate Groups. However, those Classes are designed to receive principal distributions in the same fashion as if separate schedules had been provided (with schedules based on the same underlying assumptions that apply to the related Aggregate Group schedule). If such seperate schedules had been provided for the individual Classes included in the Aggregate Groups we expect that the effective ranges for those Classes would not be narrower than those shown below for the related Aggregate Groups.

Groups	Structuring Ranges	Initial Effective Ranges
Aggregate Group I Planned Balances	Between 150% and 350% PSA	Between 150% and 350% PSA
Aggregate Group II Planned Balances	Between 170% and 270% PSA	Between 170% and 270% PSA

The Aggregate Groups listed above consist of the following Classes:

Aggregate Group I	AP, GP, PC and PE
Aggregate Group II	BA and BZ

FIGURE 2.26 Early or accelerated amortization events—PAC (agency)

Source: Fannie Mae Guaranteed REMIC Pass-Through Certificates, Fannie Mae REMIC Trust 2015–10 as published on the Fannie Mae REMIC Prospectus Supplement website, <http://www.fanniemae.com/portal/jsp/mbs/documents/remic/remicprospectussupplements.html>

pay 3.50% of interest on the certificates. The difference of 0.74% pertains to fees and expenses which are expected to be incurred by the trust.

Optional Redemption

In general, a series trust will terminate once the trustee has distributed all required principal and interest payments to the related certificate holders. The base prospectus states that "In no event will any series trust continue beyond the last day of the 60th year following the issue date of the related certificates. We do not have any option to cause an early termination of a series trust simply because the unpaid principal balance of the related pool declines to a stated percentage of the unpaid principal balance of the pool at the issue date. If specified in the related prospectus supplement, however, a third party may have the option to terminate a series trust early by purchasing all of the assets remaining in the trust."

Resecuritization is an important concept in an agency MBS market. An agency transaction creates single-class and/or multi-class securities for its customers in exchange for a transaction fee. In a resecuritization, a customer "swaps" a mortgage-related asset that it owns in exchange for a new MBS. Outstanding MBS are deposited into a new securitization trust for the purpose of aggregating a collateral pool consisting of multiple MBS. The cash

Principal Balance Schedules

Aggregate Group I Planned Balances

Distribution Date	Planned Balance	Distribution Date	Planned Balance	Distribution Date	Planned Balance
Initial Balance	$92,579,000.00	October 2019	$46,750,060.51	June 2024	$14,113,831.62
March 2015	92,274,822.79	November 2019	45,901,213.87	July 2024	13,803,877.06
April 2015	91,940,082.92	December 2019	45,058,648.59	August 2024	13,500,517.66
May 2015	91,574,881.85	January 2019	44,222,309.94	September 2024	13,203,616.08
June 2015	91,179,344.38	February 2020	43,392,143.59	October 2024	12,913,037.79
July 2015	90,753,618.61	March 2020	42,568,095.66	November 2024	12,628,651.04
August 2015	90,297,875.88	April 2020	41,750,112.68	December 2024	12,350,326.77
September 2015	89,812,310.65	May 2020	40,938,141.60	January 2025	12,077,938.57
October 2015	89,297,140.40	June 2020	40,132,129.81	February 2025	11,811,362.62
November 2015	88,752,605.45	July 2020	39,332,025.09	March 2025	11,550,477.65
December 2015	88,178,968.78	August 2020	38,537,775.64	April 2025	11,295,164.88
January 2016	87,576,515.79	September 2020	37,749,330.08	May 2025	11,045,307.97
February 2016	86,945,554.10	October 2020	36,966,637.42	June2025	10,800,792.96
March 2016	86,286,413.21	November 2020	36,189,647.07	July 2025	10,561,508.23
April 2016	85,599,444.26	December 2020	35,418,308.85	August 2025	10,327,344.49
May 2016	84,885,019.64	January 2021	34,659,683.53	September 2025	10,098,194.64
June 2016	84,143,532.64	February 2021	33,916,928.55	October 2025	9,873,953.83
July 2016	83,375,397.08	March 2021	33,189,717.41	November 2025	9,654,519.35
August 2016	82,581,046.89	April 2021	32,477,730.21	December 2025	9,439,790.59
September 2016	81,760,935.62	May 2021	31,780,653.60	January 2026	9,226,669.04
October 2016	80,915,536.02	June 2021	31,098,180.56	February 2026	9,024,058.18
November 2016	80,045,339.53	July 2021	30,430,010.34	March 2026	8,822,863.53
December 2016	79,105,855.74	August 2021	29,775,848.29	April 2026	8,625,992.49

FIGURE 2.27 Early or accelerated amortization events—TAC (agency)

Source: Fannie Mae Guaranteed REMIC Pass-Through Certificates, Fannie Mae REMIC Trust 2015–10 as published on the Fannie Mae REMIC Prospectus Supplement website, <http://www.fanniemae.com/portal/jsp/mbs/documents/remic/remicprospectussupplements.html>

Group 2 Underlying REMIC Certificates

Underlying REMIC Trust	Class	Date of Issue	CUSIP Number	Interest Rate	Interest Type(1)	Final Distribution Date	Principal Type(1)	Original Notional Principal Balance of Class	February 2015 Class Factor	Notional Principal Balance in the Lower Tier REMIC	Approximate Weighted Average WAC	Approximate Weighted Average WAM (in months)	Approximate Weighted Average WALA (in months)
2014–54	IN	August 2014	3136AKM83	3.5%	FIX/IO	August 2043	NTL	$53,573,428	0.95097175	$21,316,045.09	4.066%	332	23
2015–3	AI(2)	January 2015	3136AMNB1	3.5	FIX/IO	August 2043	NTL	35,519,714	0.99088214	35,195,850.22	4.066%	332	23

(1) See “Description of the Certificates —Class Definitions and Abbreviations” in the REMIC Prospectus.
(2) The Class 2015–3–AI REMIC Certifcate is backed by the Fannie Mae RCR Certificate listed below having the following characteristics:

Class	Interest Type	Principal Type
2014–54–NM	FIX	PAC/AD

FIGURE 2.28 Resecuritization mortgage pool characteristics (agency)

Source: Fannie Mae Guaranteed REMIC Pass-Through Certificates, Fannie Mae REMIC Trust 2015–10 as published on the Fannie Mae REMIC Prospectus Supplement website, <http://www.fanniemae.com/portal/jsp/mbs/documents/remic/remicprospectussupplements.html>

flows from the MBS collateral pool are used to create the new security(ies). There is no additional credit risk in such a resecuritization transaction, because the underlying assets are MBS for which an agency (e.g., Fannie Mae) has already provided a guaranty. The process for issuing MBS in a structured resecuritization is similar to the process involved in securitization.[33] In our example, Certificate AI in Group 2 is backed by two previously issued MBS, namely 2014-54 IN and 2015-3 AI. These previously issued certificates are backed by mortgage pools, characteristics of which can be seen in Figure 2.28.

[33] <http://www.fanniemae.com/resources/file/ir/pdf/quarterly-annual-results/2004/2004_form10K.pdf>.

Credit Enhancement and Other Support

To fully understand and analyze the securities, investors need to consider all of the available credit enhancements and support throughout the lifecycle of the MBS. The base prospectus and prospectus supplement describes both internal and external credit enhancements. Typically, an agency MBS credit enhancement is in the form of a guaranty. Some transactions may include derivative contracts such as interest rate swap agreements, and interest rate cap or floor agreements.

In the sample transaction, Figure 2.19 illustrates the disclosure of the agency guaranty on the cover page of the prospectus supplement. It also states that the certificates and payments of interest and principal on the certificates are not guaranteed by the government of the United States. The base prospectus states that the guaranty requires Fannie Mae to supplement amounts received by the series trust to permit timely payment by the series trust of the scheduled principal and interest amounts, and that the amount of principal and interest distributed to holders of certificates on a distribution date will be calculated without regard to any loss mitigation measures taken or loan modifications made to a loan backing a series trust asset while it remains in the series trust.[34]

Prepayment and Yield Considerations

The yield and prepayment section of the prospectus supplement typically receives significant attention from prospective investors. This information helps investors analyze the impact on their investment return due to various prepayment assumptions and other issues affecting yield and flow of funds to the MBS.

The yield and prepayment information includes detailed statistical and tabular data. Some of the common disclosure items include:

- percentage of the initial class balance outstanding at the end of each year;
- average life;
- yield;
- interest rate sensitivity;
- other information under specified prepayment, interest rate, or related scenarios.

Many investors reverse-engineer and create their own financial model of the MBS to perform analytics and computations using different assumptions. These computations can supplement the computational materials provided by the underwriters and the disclosures included in the prospectus supplement. An investor can compare their model output to the output in the prospectus using the same inputs and assumptions to ensure their model reflects the transaction structure.

34 <http://www.fanniemae.com/syndicated/documents/mbs/remicpros/SF_FM_June_1_2014.pdf>.

Figure 2.29 provides the modeling assumptions for the sample transaction. The first two assumptions are the use of hypothetical mortgage loan data for each loan group. The modeling assumptions on a pool-level basis are disclosed in Figure 2.21 for fixed-rate MBS groups, in Figure 2.28 for the resecuritization group, and in Figure 2.30 for the ARM MBS group.

Another important modeling assumption is the prepayment model and prepayment rate assumptions. The type of collateral securitized determines the appropriate prepayment model used by the issuer. Some transactions disclose a custom prepayment model.

The fourth assumption in Figure 2.29 indicates that the issuer is using the Prepayment Speed Assumption (PSA) model. Rather than selecting a single prepayment rate, the issuer will often disclose the yield to maturity based on a range of prepayment rates. The range of prepayments will allow investors to determine the sensitivity of their yield to changes in the rate of prepayments.

Other assumptions related to the projection of collateral cash flows include the settlement date and the distribution dates.

Based upon the modeling assumptions, the issuer prepares and discloses decrement tables that indicate the projected weighted-average life of each class of the offered certificates. In addition, the percentages of the initial class balance of each class that would be outstanding after each of the dates shown at various PSAs are disclosed. See Figure 2.31 for an example of a decrement table. The Weighted Average Life (WAL) for each security is also disclosed in the prospectus supplement (see Figure 2.22). Given that the MBS are backed by the Fannie Mae guaranty, loss assumptions are usually not run for yield and decrement tables.

Figure 2.32 discloses the general methodology used in determining the yields and Figure 2.33 shows the resulting "yield sensitivity" tables based on the purchase price of the certificate (expressed as a percentage of their initial class balance plus accrued interest).

Combination and Recombination—RCR Certificates

In an exchangeable agency transaction, investors have an option to exchange their securities. Such securities are described on the cover page and a detailed disclosure is provided as an exhibit in the Prospectus Supplement. If an investor owns a class designated as "exchangeable" on the cover of the prospectus supplement, the investor will be able to exchange this class for a proportionate interest in the related RCR certificates. A schedule in the prospectus supplement lists the available combinations of the certificates eligible for exchange and the related RCR certificates. An investor can exchange the certificates by notifying the agency and paying an exchange fee.[35]

In our example, footnote 5 on the cover page of the prospectus supplement (Figure 2.19) identifies the exchangeable securities. Furthermore, the paragraph under the table on

[35] <http://www.fanniemae.com/syndicated/documents/mbs/remicpros/SF_FM_June_1_2014.pdf>.

Structuring Assumptions

Pricing Assumptions. Except where otherwise noted, the information in the tables in this prospectus supplement has been prepared based on the actual characteristics of each pool of Mortgage Loans backing the Group 2 Underlying REMIC Certificates, the applicable priority sequence governing notional principal balance reductions on the Group 2 Underlying REMIC Certificates, and the following assumptions (such characteristics and assumptions, collectively, the "Pricing Assumptions"):

- the Mortgage Loans underlying the Fixed Rate MBS have the original terms to maturity, remaining terms to maturity, loan ages and interest rates specified under "Summary—Group 1, Group 4, Group 5, and Group 6—Assumed Characteristics of the Underlying Mortgage Loans" in this prospectus supplement;
- the Hybrid ARM Loans have the characteristics set forth in Exhibit A-2 to this prospectus supplement;
- with respect to the Hybrid ARM Loans, the One-Year WSJ LIBOR Index value is and remains 0.6636%;
- the Mortgage Loans prepay at the constant percentages of PSA specified in the related tables;
- the settlement date for the Certificates is February 27, 2015; and
- each Distribution Date occurs on the 25th day of a month.

FIGURE 2.29 Structuring assumptions (agency)

Source: Fannie Mae Guaranteed REMIC Pass-Through Certificates, Fannie Mae REMIC Trust 2015–10 as published on the Fannie Mae REMIC Prospectus Supplement website, <http://www.fanniemae.com/portal/jsp/mbs/documents/remic/remicprospectussupplements.html>

Assumed Characteristics of the Mortgage Loans Underlying the ARM MBS
(As of February 1, 2015)

Issue Date Unpaid Principal Balance	Net Mortgage Rate*(%)	Mortgage Rate (%)	Original Term (in months)	Remaining Term to Maturity (in months)	Loan Age (in months)	Margin (%)	Initial Rate Cap (%)	Periodic Rate Cap (%)	Lifetime Rate Cap (%)	Lifetime Rate Floor (%)	Months to Rate Change	Rate Reset Frequency (in months)	Payment Reset Frequency (in months)	Remaining Interest Only Period (in months)	Index**
$ 1,976,837.11	2.1750	2.750	360	219	141	2.250	***	2.000	10.1177	2.250	3	12	12	N/A	WSJ 1 Year LIBOR
2,604,699.96	2.2240	2.761	360	234	126	2.250	***	2.000	10.5438	2.250	6	12	12	N/A	WSJ 1 Year LIBOR
173,073.94	2.2470	2.848	360	249	111	2.299	***	2.000	10.8507	2.299	4	12	12	N/A	WSJ 1 Year LIBOR
1,728,268.31	2.2070	2.782	360	230	130	2.250	***	2.000	9.6979	2.250	2	12	12	N/A	WSJ 1 Year LIBOR
2,307,224.69	2.1280	2.862	360	227	133	2.250	***	2.000	10.7051	2.250	11	12	12	N/A	WSJ 1 Year LIBOR
637,989.78	2.1220	2.750	360	234	126	2.250	***	2.000	10.1374	2.250	6	12	12	N/A	WSJ 1 Year LIBOR
434,110.09	2.1850	2.829	360	237	123	2.250	***	2.000	10.2614	2.250	9	12	12	N/A	WSJ 1 Year LIBOR
7,874,122.95	2.0580	2.843	360	241	119	2.250	***	2.000	11.1215	2.250	4	12	12	1	WSJ 1 Year LIBOR
2,757,791.37	2.0750	2.750	360	244	116	2.250	***	2.000	10.6921	2.250	4	12	12	N/A	WSJ 1 Year LIBOR
421,016.96	2.0370	2.837	360	244	116	2.337	***	2.000	10.4653	2.337	4	12	12	N/A	WSJ 1 Year LIBOR
1,269,319.07	1.9350	2.780	360	243	117	2.250	***	2.000	10.7198	2.250	3	12	12	3	WSJ 1 Year LIBOR
1,314,505.61	2.1380	2.750	360	246	114	2.250	***	2.000	10.1707	2.250	6	12	12	0	WSJ 1 Year LIBOR
110,514.20	2.0140	2.791	360	246	114	2.291	***	2.000	10.9238	2.291	6	12	12	0	WSJ 1 Year LIBOR
220,428.55	2.2100	2.867	360	247	113	2.250	***	2.000	10.2914	2.250	7	12	12	N/A	WSJ 1 Year LIBOR
293,190.10	1.9780	2.784	360	248	112	2.250	***	2.000	12.1268	2.250	8	12	12	0	WSJ 1 Year LIBOR
947,546.46	2.3110	2.875	360	252	108	2.250	***	2.000	11.2047	2.250	12	12	12	N/A	WSJ 1 Year LIBOR
898,363.86	2.1790	2.774	360	249	111	2.250	***	2.000	11.7966	2.250	9	12	12	9	WSJ 1 Year LIBOR
120,496.85	2.4080	2.866	360	253	107	2.250	***	2.000	11.2844	2.250	3	12	12	N/A	WSJ 1 Year LIBOR

Expected ARM MBS

The pool numbers of the adjustable-rate MBS expected to be included in the Lower Tier REMIC are listed below:

Pool Number	Issue Date Unpaid Principal Balance
708889	$ 1,976,837.11
735352	2,604,699.96
745654	173,073.94
761661	1,728,268.31
766104	2,307,224.69
781472	637,989.78
800158	434,110.09
820936	7,874,122.95
821927	2,757,791.37
826362	421,061.96
828844	1,269,319.07

FIGURE 2.30 ARM mortgage pool characteristics (agency)

Source: Fannie Mae Guaranteed REMIC Pass-Through Certificates, Fannie Mae REMIC Trust 2015–10 as published on the Fannie Mae REMIC Prospectus Supplement website, <http://www.fanniemae.com/portal/jsp/mbs/documents/remic/remicprospectussupplements.html>

Decrement Tables

The following tables indicate the percentages of original principal balances of the specified Classes that would be outstanding after each date shown at various constant PSA rates, and the corresponding weighted average lives of those Classes. The tables have been prepared on the basis of the Pricing Assumptions.

In the case of the information set forth for each Class (other than the Group 3 Classes) under 0% PSA, however, we assumed that the Mortgage Loans have the original and remaining terms to maturity and bear interest at the annual rates specified in the table below.

Mortgage Loans Backing Trust Assets Specified Below	Original Terms to Maturity	Remaining Terms to Maturity	Interest Rates
Group 1 MBS	360 months	360 months	6.00%
Group 2 Underlying REMIC Certificates	360 months	354 months	6.00%
Group 4 MBS	360 months	360 months	6.50%
Group 5 MBS	360 months	360 months	6.00%
Group 6 MBS	360 months	360 months	5.50%

It is unlikely that all of the Mortgage Loans will have the loan ages, interest rates or remaining terms to maturity assumed, or that the Mortgage Loans will prepay at any *constant* PSA level.

In addition, the diverse remaining terms to maturity of the Mortgage Loans could produce slower or faster principal distributions than indicated in the tables at the specified constant PSA rates, even if the weighted average remaining term to maturity and the weighted average loan age of the Mortgage Loans are identical to the weighted averages specified in the Pricing Assumptions. This is the case because pools of loans with identical weighted averages are nonetheless likely to reflect differing dispersions of the related characteristics.

Percent of Original Principal Balances Outstanding

	AP, GP and PI† Classes PSA Prepayment Assumption							PC Class PSA Prepayment Assumption							PE Class PSA Prepayment Assumption						
Date	0%	100%	150%	180%	350%	700%	1100%	0%	100%	150%	180%	350%	700%	1100%	0%	100%	150%	180%	350%	700%	1100%
Initial Percent	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
February 2016	97	95	94	94	94	94	94	97	95	94	94	94	94	94	100	100	100	100	100	100	100
February 2017	95	87	83	83	83	81	59	94	86	83	83	83	80	56	100	100	100	100	100	100	100
February 2018	92	77	70	70	70	47	21	91	75	69	69	69	44	16	100	100	100	100	100	100	100
February 2019	89	67	58	58	58	27	7	88	65	56	56	56	23	2	100	100	100	100	100	100	100
February 2020	86	58	47	47	47	15	2	85	56	44	44	44	11	0	100	100	100	100	100	100	47
February 2021	82	49	37	37	37	9	1	81	46	33	33	33	4	0	100	100	100	100	100	100	16
February 2022	79	41	28	28	28	5	*	78	38	25	25	25	*	0	100	100	100	100	100	100	5
February 2023	75	33	22	22	22	3	*	74	29	18	18	18	0	0	100	100	100	100	100	57	2
February 2024	71	25	17	17	17	2	*	70	21	12	12	12	0	0	100	100	100	100	100	32	1
February 2025	67	18	13	13	13	1	*	65	14	8	8	8	0	0	100	100	100	100	100	18	*
February 2026	63	11	10	10	10	*	*	61	7	5	5	5	0	0	100	100	100	100	100	10	*
February 2027	58	7	7	7	7	*	*	56	3	3	3	3	0	0	100	100	100	100	100	6	*
February 2028	53	6	6	6	6	*	*	51	1	1	1	1	0	0	100	100	100	100	100	3	*
February 2029	48	4	4	4	4	*	*	45	0	0	0	0	0	0	100	89	89	89	89	2	*
February 2030	43	3	3	3	3	*	*	40	0	0	0	0	0	0	100	67	67	67	67	1	*
February 2031	37	2	2	2	2	*	*	34	0	0	0	0	0	0	100	50	50	50	50	1	*
February 2032	31	2	2	2	2	*	*	28	0	0	0	0	0	0	100	38	38	38	38	*	*
February 2033	25	1	1	1	1	*	*	21	0	0	0	0	0	0	100	28	28	28	28	*	*
February 2034	18	1	1	1	1	*	0	14	0	0	0	0	0	0	100	21	21	21	21	*	*
February 2035	11	1	1	1	1	*	0	7	0	0	0	0	0	0	100	15	15	15	15	*	*
February 2036	4	1	1	1	1	*	0	0	0	0	0	0	0	0	86	11	11	11	11	*	0
February 2037	*	*	*	*	*	*	0	0	0	0	0	0	0	0	8	8	8	8	8	*	0
February 2038	*	*	*	*	*	*	0	0	0	0	0	0	0	0	5	5	5	5	5	*	0
February 2039	*	*	*	*	*	*	0	0	0	0	0	0	0	0	4	4	4	4	4	*	0
February 2040	*	*	*	*	*	*	0	0	0	0	0	0	0	0	3	3	3	3	3	*	0
February 2041	*	*	*	*	*	*	0	0	0	0	0	0	0	0	2	2	2	2	2	*	0
February 2042	*	*	*	*	*	*	0	0	0	0	0	0	0	0	1	1	1	1	1	*	0
February 2043	*	*	*	*	*	*	0	0	0	0	0	0	0	0	*	*	*	*	*	*	0
February 2044	*	*	*	*	*	*	0	0	0	0	0	0	0	0	*	*	*	*	*	*	0
February 2045	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Weighted Average Life (years)**	12.8	6.4	5.6	5.6	5.6	3.3	2.4	12.3	5.9	5.0	5.0	5.0	3.1	2.2	21.5	17.0	17.0	17.0	17.0	8.8	5.3

FIGURE 2.31 Decrement table (agency)

Source: Fannie Mae Guaranteed REMIC Pass-Through Certificates, Fannie Mae REMIC Trust 2015–10 as published on the Fannie Mae REMIC Prospectus Supplement website, <http://www.fanniemae.com/portal/jsp/mbs/documents/remic/remicprospectussupplements.html>

Yield Tables and Additional Yield Considerations

General. The tables below illustrate the sensitivity of the pre-tax corporate bond equivalent yields to maturity of the applicable Classes to various constant precentages of PSA and, where specified, to changes in the Index. **The tables below are provided for illustrative purposes only and are not intended as a forecast or prediction of the actual yields on the applicable Classes**. We calculated the yields set forth in the tables by

- determining the monthly discount rates that, when applied to the assumed streams of cash flows to be paid on the applicable Classes, would cause the discounted present values of the assumed streams of cash flows to equal the assumed aggregate purchase prices of those Classes, and
- converting the monthly rates to corporate bond equivalent rates.

These calculations do not take into account variations in the interest rates at which you could reinvest distributions on the Certificates. Accordingly, these calculations do not illustrate the return on any investment in the Certificates when reinvestment rates are taken into account.

We cannot assure you that

- the pre-tax yields on the applicable Certificates will correspond to any of the pre-tax yields shown here, or
- the aggregate purchase prices of the applicable Certificates will be as assumed.

In addition, it is unlikely that the Index will correspond to the levels shown here.Furthermore, because some of the Mortgage Loans are likely to have remaining terms to maturity shorter or longer than those assumed and interest rates higher or lower than those assumed, the notional principal balance reductions on the Certificates are likely to differ from those assumed. This would be the case even if all Mortgage Loans prepay at the indicated constant percentages of PSA.Moreover, it is unlikely that

- the Mortgage Loans will prepay at a constant PSA rate until maturity,
- all of the Mortgage Loans will prepay at the same rate, or
- the level of the Index will remain constant.

FIGURE 2.32 Yield information (agency)

Source: Fannie Mae Guaranteed REMIC Pass-Through Certificates, Fannie Mae REMIC Trust 2015–10 as published on the Fannie Mae REMIC Prospectus Supplement website, <http://www.fanniemae.com/portal/jsp/mbs/documents/remic/remicprospectussupplements.html>

the cover page lists the RCR Certificates. Figure 2.34 in our example provides the detailed schedule of the exchangeable and RCR Certificates with balances, principal type, interest rate and type, CUSIP, and final Distribution Date. It also specifies the proportion based on the balance in which the securities can be exchanged.

Risk Factors

Many risk factors are common to agency MBS. Issuers typically include an explanation of how each risk may affect investors' return or yield. Risk factors include:

- characteristics of the asset pool;
- structure of the securities;

The Fixed Rate Interest Only Classes. **The yields to investors in the Fixed Rate Interest Only Classes will be very sensitive to the rate of principal payments (including prepayments) of the related Mortgage Loans. The Mortgage Loans generally can be prepaid at any time without penalty. On the basic of the assumpations described below,**

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the yield to maturity on each Fixed Rate Interest Only Class would be 0% if prepayments of the related Mortgage Loans were to occur at the following constant rates:

Class	%PSA
PI	449%
AI	311%
KI	145%

For any Fixed Rate Interest Only Class, if the actual prepayment rate of the related Mortgage Loans were to exceed the level specified for as little as one month while equaling that level for the remainng months, the investors in the applicable class would lose money on their initial investments

The information shown in the following yield tables has been prepared on the basis of the Pricing Assumptions and the assumption that the aggregate purchase prices of the Fixed Rate Interest Only Classes (expressed in each case as a percentage of the original principal balance) are as follows:

Class	Price*
PI	16.25%
AI	14.50%
KI	13.00%

* The prices do not include accrued interest. Accrued interest has been added to the prices in calcuting the yields set forth in the tables below.

In the following yield tables, the symbol * is used to represent a yield of less than (99.9)%

Sensitivity of the PI Class to Prepayments

	PSA Prepayments Assumption						
	50%	**100%**	**150%**	**180%**	**350%**	**700%**	**1100%**
Pre-Tax Yields to Maturity	12.3%	7.7%	4.4%	4.4%	4.4%	(13.1)%	(35.6)%

FIGURE 2.33 Yield sensitivity (agency)

Source: Fannie Mae Guaranteed REMIC Pass-Through Certificates, Fannie Mae REMIC Trust 2015–10 as published on the Fannie Mae REMIC Prospectus Supplement website, <http://www.fanniemae.com/portal/jsp/mbs/documents/remic/remicprospectussupplements.html>

- parties to the transaction;
- industry-specific risks;
- general economic conditions.

The prospectus and prospectus supplement generally list the risk factors associated with an investment in the MBS. Investors should review these risk factors before investing in the MBS.

In our sample MBS, Figure 2.35 shows the disclosure of the additional risk factors in the prospectus supplement. The general risk factors are covered in the base prospectus.

Available Recombinations(1)

REMIC Certificates		RCR Certificates						
Classes	Original Balances	RCR Classes	Original Balances	Principal Type(2)	Interest Rate	Interest Type(2)	CUSIP Number	Final Distribution Date
Recombination 1								
BZ	$ 1,631,000	MZ	$ 27,460,476	SUP	3.50%	FIX/Z	3136AMA74	March 2045
Z	25,829,476							
Recombination 2								
KA	161,014,000	KB	161,014,000	SEQ	2.00	FIX	3136AMA90	July 2040
		KI	53,671,333(3)	NTL	3.00	FIX/IO	3136AMB32	July 2040
Recombination 3								
KA	161,014,000	KC	161,014,000	SEQ	2.25	FIX	3136AMB24	July 2040
		KI	40,253,500(3)	NTL	3.00	FIX/IO	3136AMB32	July 2040
Recombination 4								
KA	161,014,000	KT(4)	224,050,419	PT	3.00	FIX	3136AMA82	March 2045
AV	14,297,000							
BV	12,550,000							
KZ	36,189,419							

(1) REMIC Certificates and RCR Certificates in each Recombination may by exchanged only in the proportions of *original* principal or notional principal balances for the related Classes shown in this Schedule 1 (disregarding any retired Classes). For example, if a particular Recombination includes two REMIC Classes and one RCR Class whose *original* principal balances shown in the schedule reflect a 1:1:2 relationship, the same 1:1:2 relationship among the *original* principal balances of those REMIC and RCR Classes must be maintained in any exchange. This is true even if, as a result of the applicable payment priority sequence, the relationship between their *current* principal balances has changed over time. Moreover, if as a result of a proposed exchange, a Certificateholder would hold a REMIC Certificate or RCR Certificate of a Class in an amount less than the applicable minimum denomination for that Class, the Certificateholder will be unable to effect the proposed exchange. See"Description of the Certificates–General–*Authorized Denominations*" in this prospectus supplement.
(2) See "Description of the Certificates–Class Definitions and Abbreviations" in the REMIC Prospectus.
(3) Notional principal balance. This Class in an Interest Only Class. See page S–6 for a description of how its notional principal balance is calculated.
(4) Principal payments on the REMIC Certificates in Recombination 4 from the KZ Accrual Amount will be paid as interest on the related RCR Certificates, and thus will not reduce the principal balances of those RCR Certificates.

FIGURE 2.34 Exchangeable and RCR Certificates information (agency)

Source: Fannie Mae Guaranteed REMIC Pass-Through Certificates, Fannie Mae REMIC Trust 2015–10 as published on the Fannie Mae REMIC Prospectus Supplement website, <http://www.fanniemae.com/portal/jsp/mbs/documents/remic/remicprospectussupplements.html>

ADDITIONAL RISK FACTOR

Payments on the Group 2 Class will be affected by the applicable payment priority governing the Group 2 Underlying REMIC Certificates. If you invest in the Group 2 Class, the rate at which you receive payments will be affected by the applicable priority sequence governing notional principal balance reductions on the Group 2 Underlying REMIC Certificates.

In particular, as described in the related Underlying REMIC Disclosure Documents, notional principal balance reductions on the Group 2 Underlying REMIC Certificates are governed by a principal balance schedule. As a result, the Group 2 Underlying REMIC Certificates may experience notional principal balance reductions faster or slower than would otherwise have been the case. Prepayments on the related mortgage loans may have occurred at a rate faster or slower than the rate initially assumed. In certain high prepayment scenarios, it is possible that the effect of a principal balance schedule on notional principal balance reductions over time may be eliminated. In such a case, the Group 2 Underlying REMIC Certificates would experience notional principal balance reductions at rates that may very widely from period to period. This prospectus supplement contains no information as to whether

- the Group 2 Underlying REMIC Certificates have adhered to the related principal balance schedule,
- any related support classes remain outstanding, or
- the Group 2 Underlying REMIC Certificates otherwise have performed as originally anticipated.

You may obtain additional information about the Group 2 Underlying REMIC Certificates by reviewing their current class factors in light of other information available in the Underlying REMIC Disclosure Documents. You may obtain those documents from us as described on page S-3.

FIGURE 2.35 Risk factors (agency)

Source: Fannie Mae Guaranteed REMIC Pass-Through Certificates, Fannie Mae REMIC Trust 2015–10 as published on the Fannie Mae REMIC Prospectus Supplement website, <http://www.fanniemae.com/portal/jsp/mbs/documents/remic/remicprospectussupplements.html>

Weighted Average Lives of the Certificates

For a description of how the weighted average life of a Certificate is determined, see "Yield, Maturity and Prepayment Considerations—Weighted Average Lives and Final Distribution Dates" in the REMIC Prospectus.

In general, the weighted average lives of the Certificates will be shortened if the level of prepayments of principal of the related Mortgage Loans increases. However, the weighted average lives will depend upon a variety of other factors, including

- the timing of changes in the rate of principal distributions
- the priority sequences of distributions of principal of the Group 1, Group 4, Group 5 and Group 6 Classes, and
- in the case of the Group 2 Class, the applicable priority sequence affecting notional principal balance reductions on the Group 2 Underlying REMIC Certificates.

See "—Distributions of Principal" above and "Description of the Certificates—Distributions of Principal" in the Underlying REMIC Disclosure Documents.

The effect of these factors may differ as to various Classes and the effects on any Class may vary at different times during the life of that Class. Accordingly, we can give no assurance as to the weighted average life of any Class. Further, to the extent the prices of the Certificates represent discounts or premiums to their original principal balances, variability in the weighted average lives of those Classes of Certificates could result in variability in the related yields to maturity. For an example of how the weighted average lives of the Classes may be affected at various constant prepayment rates, see the Decrement Tables below.

FIGURE 2.36 Weighted-average life of the Certificates (agency)

Source: Fannie Mae Guaranteed REMIC Pass-Through Certificates, Fannie Mae REMIC Trust 2015–10 as published on the Fannie Mae REMIC Prospectus Supplement website, <http://www.fanniemae.com/portal/jsp/mbs/documents/remic/remicprospectussupplements.html>

Risk factors[36] include, but are not limited to:

- Risk relating to yield and prepayment:
  - o Yield on and weighted-average life of the certificates are affected by actual characteristics of the mortgage loans backing the certificates. The risks around the weighted-average life can be seen in Figure 2.36.
  - o Yield on certificates may be lower than expected due to an unexpected rate of principal prepayments.
  - o Delay Classes generally have lower market values.
  - o Level of a floating rate index affects yields on certain certificates.
  - o Basis risk may adversely affect the yield on the certificates.
  - o Intercontinental Exchange Benchmark Administration (ICE) is the new LIBOR administrator. Although ICE has provided assurances that there will be no initial changes to the manner in which the rate is calculated or to data collection

[36] <http://www.fanniemae.com/syndicated/documents/mbs/remicpros/SF_FM_June_1_2014.pdf>.

methodologies, Fannie Mae can provide no assurance that there will be no such changes in the future.

- Risk relating to liquidity:
  - o There may be no market for the certificates.
  - o Basel III and US capital and liquidity rules could materially and adversely affect demand by banks for the certificates in the future.
  - o Any subsequent required limit or reduction in the mortgage portfolio assets of Fannie Mae may adversely affect the liquidity of the certificates.
- Risk relating to credit:
  - o If Fannie Mae's credit becomes impaired, a buyer may be willing to pay only a reduced price for the certificates.
  - o If Fannie Mae fails to pay under the guaranty, the amount distributed to certificate holders could be reduced, and the timing of distributions could be affected.
  - o As conservator, the Federal Housing Finance Agency ("FHFA") has certain rights to transfer Fannie Mae and Freddie Mac assets and liabilities, including the guaranty.

Key Points

- The prospectus is the cornerstone disclosure document available to an investor and describes the nature of the MBS, the key characteristics about the mortgage pool backing the MBS, risk factors associated with investing in the offered MBS, and the legal structure of the MBS including parties involved in the creation and maintenance of the trust. These disclosures are designed to provide information to investors so that they can make an informed investment decision.
- Disclosures are driven by legislative action as well as investor demands.
- The MBS market was dominated by private-label issuance prior to the financial crisis and agency or government issuance post financial crisis.
- The financial crisis had a significant impact on the disclosure framework for MBS.
- Legislation impacting the required disclosures for an MBS and the MBS offering process was issued by the SEC in August 2014 (effective starting November 2015).
- Major legislative changes include: (1) use of one prospectus (combining the base prospectus and the prospectus supplement); (2) a certification by the chief executive officer of the depositor regarding the disclosures in the prospectus and the structure of the securitization at the time of filing for each takedown; (3) filing of the preliminary prospectus with the SEC at least three business days prior to the first sale of the MBS; (4) more investor protections such as dispute resolution procedures and disclosure of investors' requests to communicate with other investors related to exercising their rights; and (5) requiring the issuer to maintain timely Exchange Act reporting in, and timely filing of, transaction requirements for previous shelf offerings.
- Significant new disclosure requirements under Regulation AB II include: (1) the sponsor's retained economic interest in the transaction in order to comply with law, and the amount and nature of the retained interest including the effect of any economic hedges; (2) static pool information including a narrative of the static pool information to aid investors in their review of such information; (3) a review of the pool assets designed to provide reason-

able assurance that the disclosures of the pool assets in the prospectus are accurate in all material respects; and (4) granular asset-level disclosures (270 data points for residential MBS and 152 data points for commercial MBS).

- With respect to the granular asset-level disclosure, the data points are required for each mortgage in the pool and include information about the property, mortgage, obligor's creditworthiness, payment history, original and current mortgage terms, and loan performance information.
- In an agency issuance, prepayment risk is generally considered the most significant risk.
- Disclosures in an agency MBS issuance are less granular than a private-label MBS issuance given the agency or government guaranty.

Acknowledgment

PricewaterhouseCoopers has prepared this chapter regarding the prospectus and prospectus supplement in order to provide a framework for a general understanding to a user of such information. PricewaterhouseCoopers does not practice law, and is not in this chapter interpreting the requirements of the US securities law and regulations or providing legal advice. Readers should seek advice from legal counsel with regard to any matters of law related to the preparation or understanding of a prospectus or prospectus supplement. "PricewaterhouseCoopers" refers to PricewaterhouseCoopers LLP, a Delaware limited liability partnership or, as the context requires, the network of member firms of PricewaterhouseCoopers International Limited, each of which is a separate and independent legal entity.

CHAPTER 3

CASH FLOW MATHEMATICS FOR AGENCY MORTGAGE-BACKED SECURITIES

FRANK J. FABOZZI

After reading this chapter you will understand:

- how to compute the cash flow of different types of mortgage loans;
- how a pool of mortgage loans is described in terms of coupon rates and remaining life;
- the various measures for describing prepayments (conditional prepayment rate and single monthly mortality rate);
- the relationship between the Public Securities Association Prepayment Benchmark and conditional prepayment rates;
- given a prepayment rate assumption, how to compute the cash flow of an agency mortgage passthrough security;
- the components of an agency mortgage passthrough security: interest, scheduled principal, and prepayments;
- how the projected cash flow for the bond classes of a multi-class MBS is determined given the projected cash flow of the underlying collateral;
- what the average life of an MBS is and how it is calculated.

The calculation of the cash flow of a mortgage-backed security (MBS) depends on the assumed prepayment rate for the pool of loans backing the security. Once a prepayment assumption is made, the cash flow for an agency MBS can be derived. For a non-agency MBS, an assumption for both the prepayment rate and default/recovery rates must be made. In this chapter, our focus is on computing the components of the cash flow for an agency MBS—interest, scheduled principal, and prepayments—given an assumed prepayment rate. A discussion of prepayment modeling is not covered in this chapter.

Constructing the Cash Flow for Mortgage Loans

As explained in Chapter 1, there are various types of mortgage design. A loan where the mortgage payment includes scheduled principal payments is referred to as an *amortizing mortgage*. A mortgage loan requiring the borrower to only make interest payments over the term of the loan and repay the entire principal at the end of the loan term is called an *interest-only loan*. Another design feature of a mortgage loan is the interest rate. It can be (1) a fixed rate, (2) a floating rate, or (3) a fixed rate for a specified period of time and then a floating rate thereafter.

Here we will look at the cash flow characteristics of mortgage loans. We begin with a level-payment fixed-rate mortgage and then discuss adjustable-rate mortgages.

Level-Payment Fixed-Rate Mortgage

The monthly mortgage payment for a level-payment fixed-rate mortgage is:[1]

$$MP = MB_0\left[\frac{i(1+i)^n}{(1+i)^n-1}\right] \tag{1}$$

where

MB_0 = Original mortgage balance (\$)
MP = Monthly mortgage payment (\$)
i = Simple monthly interest rate (annual interest rate/12)
n = Term of the loan in months

Monthly mortgage payments are due on the first of the month. For a level-payment fixed-rate mortgage, the monthly mortgage payment includes (1) interest equal to one-twelfth of the fixed annual interest rate times the amount of the outstanding mortgage balance at the beginning of the previous month (interest "in arrears") and (2) repayment of a portion of the outstanding mortgage balance (principal repayment). The difference between the monthly mortgage payment and the portion of the payment representing the monthly interest equals the amount that is applied to reduce the outstanding mortgage balance.

[1] The formula is derived by applying the formula for the present value of an ordinary annuity formula.

The two major characteristics of this mortgage design are that:

- the portion of the monthly mortgage payment applied to interest declines each month, and therefore the portion that goes to reducing the mortgage balance increases;
- after the last scheduled monthly mortgage payment is made, the amount of the outstanding mortgage balance is zero (i.e., the mortgage is fully repaid).

The reason for the first characteristic is that as the mortgage balance is reduced with each monthly mortgage payment, the interest on the mortgage balance declines. Since the monthly mortgage payment is fixed (i.e., level payment), a larger portion of the monthly payment is applied to reduce the principal each month.

For a seasoned mortgage loan, the remaining mortgage balance for any month is determined as follows:

$$MB_t = MB_0 \left[\frac{i(1+i)^n - i(1+i)^t}{(1+i)^n - 1} \right] \tag{2}$$

where

MB_t = mortgage balance after t months ($)
MB_0 = original mortgage balance ($)
i = simple monthly interest rate (annual interest rate/12)
n = original term of the mortgage in months.

To determine the amount of the scheduled principal repayment in month t, the following formula can be used:

$$P_t = MB_0 \left[\frac{i(1+i)^{t-1}}{(1+i)^n - 1} \right]$$

where P_t = scheduled principal repayment for month t.

Adjusting Cash Flow to the Investor for Servicing Fee and Guarantee Fee

Mortgage loans must be serviced. As a result, the mortgage lender receives the monthly mortgage payment reduced by the amount of the servicing fee. The activities associated with servicing of the mortgage loan involve collecting monthly payments from mortgagors, sending payment notices to mortgagors, reminding mortgagors when payments are overdue, maintaining records of mortgage balances, furnishing tax information to mortgagors, administering an escrow account for real estate taxes and insurance purposes, and, if necessary, initiating foreclosure proceedings. Thus, a portion of a mortgage loan's interest rate includes the cost of servicing the mortgage. The servicing fee is a fixed percentage of the outstanding mortgage balance.

The monthly cash flow from the mortgage can therefore be decomposed into three parts: (1) the amount to service the mortgage, (2) the interest payment net of the servicing fee, and (3) the scheduled principal repayment.

Adjustable-Rate Mortgages

An adjustable-rate mortgage (ARM) has an adjustable or floating coupon rate instead of a fixed one. The coupon rate adjusts periodically—monthly, semiannually, or annually. An ARM has a formula for determining the coupon rate at the reset date called the *coupon reset formula*. This formula is expressed in terms of an index level (or reference rate) plus a margin.

When an ARM is originated, it usually has an initial interest rate for an initial period (*teaser period*) which is slightly below the rate specified by the coupon reset formula. This below-formula interest rate is referred to as a *teaser rate*. After the teaser period, the interest rate is reset based on the coupon reset formula. Once the loan comes out of its teaser period and resets based on the coupon formula, it is said to be *fully indexed*. Since the borrower prefers to be warned in advance of any interest rate adjustment, the coupon determination actually has to take place prior to the coupon reset. This is called the *lookback period*.

To protect the borrower from a significant spike in the interest rate due to a rise in market rates, there are caps or ceilings imposed on the coupon adjustment level. There are two types of caps. The first is a *periodic cap* limiting the amount that the coupon rate can reset upward from one reset period to another. The second is the maximum absolute level for the coupon rate that the loan can reset over the life of the mortgage, called the *lifetime cap*. In addition, there are periodic and lifetime floors below which the mortgage rate can fall.

Obviously, the monthly mortgage payments over an ARM's life will change. When the loan is originated, the teaser rate is used to determine the monthly mortgage payment. The formula used for computing the monthly mortgage payment until the next reset date is just a modification of equation (1), the formula given earlier for a fixed-rate, level payment mortgage, as described in equation (3) below.

The monthly mortgage payment is recalculated at the coupon reset date. The new mortgage rate is determined using the coupon reset formula, taking into consideration any restrictions on the mortgage rate due to periodic and lifetime caps and floors. Letting j denote the month when the mortgage rate is reset, MB_j the outstanding mortgage balance at j, and T the number of months remaining at the reset month, then the monthly mortgage payment (MP) from month j until the next reset date is found as follows:

$$MP = MB_j \left[\frac{i(1+i)^T}{[(1+i)^T - 1]} \right] \tag{3}$$

Hybrid ARMs

A hybrid mortgage is a form of ARM design wherein the mortgage rate is fixed for a period of time and floats thereafter. For example, for a 30-year mortgage, a hybrid mortgage can have a fixed rate for three years and then become an ARM after the third year. While the frequency of resetting after the third year can be any length of time, typically it is one year. These mortgages are typically referred to as 3/1, 5/1, 7/1, and 10/1 ARMs, the first term referring to the period in years during which the mortgage rate is fixed and the second term referring to the frequency of reset during the adjustable-rate period.

The monthly mortgage payment at origination is determined using equation (1). At each reset date the monthly mortgage payment is determined using equation (3).

Describing the Mortgage Pool

As we move from individual mortgage loans to securities backed by a pool of mortgage loans, it is necessary to describe several features of the loans comprising the pool. Although there are various summary measures such as the average loan-to-value ratio, here we focus on only two features: the average interest rate (or coupon rate) and the amount of seasoning/remaining life of the loan pool.

Weighted Average Coupon Rate

Not all of the loans that are included in a pool of loans for an MBS have the same loan or contract rate. The *gross weighted average coupon rate*, or gross WAC, is found by weighting the contract rate for each loan in the pool by the percentage of the outstanding loan balance relative to the outstanding loan balance of all the loans in the pool.

Letting:

r_i = the contract rate for loan i
w_i = outstanding balance of loan i/outstanding loan balance of all loans in the pool
N = total number of loans

then the gross WAC is computed as follows:

$$\text{gross WAC} = r_1 w_1 + r_2 w_2 + \ldots + r_N w_N$$

For any month, the product of the gross WAC and the outstanding mortgage balance is the potential dollar interest (ignoring defaults) available to pay interest to bond classes in the structure before the payment of any fees.

The *net WAC* is computed by subtracting from the gross WAC the (1) servicing fee, (2) trustee fee, and (3) the payment for credit support such as the guaranty fee. The product of the net WAC and the pool's outstanding loan balance is the amount available to pay interest to the bond classes in the structure, assuming the payments are realized. In many structures, the net WAC is established as the rate that will be paid to some bond classes.

Certain bond classes in a non-agency MBS structure are interested in the amount available after paying the holders of all bond classes in a structure and all fees ignoring any potential losses. This amount, referred to as the *gross excess spread*, can be used to provide credit enhancement for a structure. In a non-agency structure, reducing the gross excess spread by the amount required to cover losses is called the *net excess spread*. Depending upon the structure, a portion of the excess spread may have to be retained by a special purpose vehicle (SPV) to build credit support over time. The net excess spread after the amount that must be retained by the SPV is called the *free excess spread* and this amount can be distributed to the issuer.

Average Age of the Loan Pool

Not all loans in a pool have the same maturity. The loans may have different maturities remaining once they have seasoned. A loan pool's *weighted average maturity* (WAM) is calculated by weighting the remaining number of months to maturity for each loan in the pool by the amount of the outstanding loan balance.[2]

Once a mortgage is seasoned, additional information is needed about the underlying loan pool as the WAM changes. The *weighted average remaining maturity* (WARM) or *weighted average remaining time* (WART) is the WAM for the pool after the issuance date.

For Freddie Mac and Ginnie Mae mortgage passthrough securities, the remaining number of months is reported each month and called the *weighted average loan age* (WALA). Due to partial prepayments, called curtailments, the WALA is not simply the original term of the mortgages less the WARM. A measure similar to WALA to measure the remaining number of months for the underlying mortgages is reported by Fannie Mae for its mortgage passthrough security and is referred to as the *calculated loan age* (CAGE).

Prepayments Measures

Any loan payment that is in excess of the scheduled principal payment and interest is called a prepayment. In describing prepayments for a pool of loans, a *prepayment rate* or *prepayment speed* is calculated.

Single Monthly Mortality Rate

The *single monthly mortality rate* (SMM) is the most commonly used measure of monthly prepayments. The calculation of the SMM begins with the determination of the amount available in the loan pool to prepay that month. The amount available in the loan pool to prepay in a month, say month *t*, is the beginning loan balance in month *t* reduced by the scheduled principal payment in month *t*. The SMM for a month *t* is then computed as follows:

[2] Letting L_i equal the number of months remaining for loan *I*, then the WAM is calculated as follows:

$$\text{WAM} = r_1 L_1 + r_2 L_2 + \ldots + r_N L_N$$

$$\text{SMM}_t = \frac{\text{Prepayment in month } t}{\text{Beginning balance for month } t - \text{Scheduled principal payment in month } t}$$

The interpretation of the SMM is as follows. An SMM_K of α% is interpreted as follows: In month K, α% of the outstanding mortgage balance available to prepay in month K prepaid.

The SMM is computed for a month. Later in this chapter we will see how it is used in projecting the amount of prepayments for a mortgage pool. That is, the prepayment for a month is used to compute the cash flow of a mortgage pool for the month. What is important to understand at this junction is that given a projected SMM for month t, the projected prepayment for month t is found as follows:

$$\begin{aligned}\text{Prepayment for month } t = \text{SMM}_t \times (&\text{Beginning balance for month } t - \text{Scheduled} \\ &\text{principal payment for month } t)\end{aligned} \tag{4}$$

Conditional Prepayment Rate

When the SMM is annualized, the resulting prepayment measure is called the *conditional prepayment rate* (CPR). Given the SMM for a given month, the CPR is found using the following formula:

$$\text{CPR} = 1 - (1 - \text{SMM})^{12} \tag{5}$$

A CPR of β% means that, ignoring scheduled principal payments, approximately β% of the mortgage pool's outstanding loan balance at the beginning of the year will be prepaid by the end of the year.

This measure is referred to as a "conditional" prepayment rate because the prepayments in one year depend upon (i.e., are conditional upon) the amount available to prepay in the previous year.

An SMM for a given CPR can be obtained using the following formula:

$$\text{SMM} = 1 - (1 - \text{CPR})^{1/12} \tag{6}$$

PSA Standard Prepayment Benchmark

The Public Securities Association (PSA) standard prepayment benchmark is expressed as a series of monthly CPRs.[3] The benchmark PSA model assumes that prepayment rates

[3] Although the Public Securities Association changed its name to the Bond Market Association (BMA) in 1997 and in 2006 the BMA merged with the Securities Industry Association to create the Securities Industry and Financial Markets Association (SIFMA), the benchmark is still referred to as the PSA benchmark.

Table 3.1 PSA Prepayment Benchmark CPR and SMM: 100, 90, 165, and 300 PSA

	100 PSA		90 PSA		165 PSA		300 PSA	
Month	CPR	SMM	CPR	SMM	CPR	SMM	CPR	SMM
1	0.00200	0.000167	0.00180	0.000150	0.00330	0.000275	0.00600	0.000501
2	0.00400	0.000334	0.00360	0.000300	0.00660	0.000552	0.01200	0.001006
3	0.00600	0.000501	0.00540	0.000451	0.00990	0.000829	0.01800	0.001513
4	0.00800	0.000669	0.00720	0.000602	0.01320	0.001107	0.02400	0.002022
5	0.01000	0.000837	0.00900	0.000753	0.01650	0.001386	0.03000	0.002535
6	0.01200	0.001006	0.01080	0.000904	0.01980	0.001665	0.03600	0.003051
7	0.01400	0.001174	0.01260	0.001056	0.02310	0.001946	0.04200	0.003569
8	0.01600	0.001343	0.01440	0.001208	0.02640	0.002227	0.04800	0.004091
9	0.01800	0.001513	0.01620	0.001360	0.02970	0.002509	0.05400	0.004615
10	0.02000	0.001682	0.01800	0.001513	0.03300	0.002792	0.06000	0.005143
11	0.02200	0.001852	0.01980	0.001665	0.03630	0.003077	0.06600	0.005674
12	0.02400	0.002022	0.02160	0.001818	0.03960	0.003361	0.07200	0.006208
13	0.02600	0.002193	0.02340	0.001971	0.04290	0.003647	0.07800	0.006745
14	0.02800	0.002364	0.02520	0.002125	0.04620	0.003934	0.08400	0.007285
15	0.03000	0.002535	0.02700	0.002278	0.04950	0.004222	0.09000	0.007828
16	0.03200	0.002707	0.02880	0.002432	0.05280	0.004510	0.09600	0.008375
17	0.03400	0.002878	0.03060	0.002586	0.05610	0.004800	0.10200	0.008925
18	0.03600	0.003051	0.03240	0.002741	0.05940	0.005090	0.10800	0.009479
19	0.03800	0.003223	0.03420	0.002896	0.06270	0.005381	0.11400	0.010036
20	0.04000	0.003396	0.03600	0.003051	0.06600	0.005674	0.12000	0.010596
21	0.04200	0.003569	0.03780	0.003206	0.06930	0.005967	0.12600	0.011160
22	0.04400	0.003743	0.03960	0.003361	0.07260	0.006261	0.13200	0.011728
23	0.04600	0.003917	0.04140	0.003517	0.07590	0.006556	0.13800	0.012299
24	0.04800	0.004091	0.04320	0.003673	0.07920	0.006852	0.14400	0.012873
25	0.05000	0.004265	0.04500	0.003830	0.08250	0.007150	0.15000	0.013452
26	0.05200	0.004440	0.04680	0.003986	0.08580	0.007448	0.15600	0.014034
27	0.05400	0.004615	0.04860	0.004143	0.08910	0.007747	0.16200	0.014620
28	0.05600	0.004791	0.05040	0.004300	0.09240	0.008047	0.16800	0.015210
29	0.05800	0.004967	0.05220	0.004458	0.09570	0.008348	0.17400	0.015804
30	0.06000	0.005143	0.05400	0.004615	0.09900	0.008650	0.18000	0.016402
31–360	0.06000	0.005143	0.05400	0.004615	0.09900	0.008650	0.18000	0.016402

will be low for newly originated mortgages and then will speed up as the mortgages become seasoned. More specifically, the PSA standard benchmark assumes the following prepayment rates for 30-year mortgages:

(1) a CPR of 0.2% for the first month, increased by 0.2% per month for the next 30 months when it reaches 6% per year, and
(2) a 6% CPR for the remaining years.

This benchmark is referred to as "100 PSA" and can be expressed mathematically as follows:

$$\text{if } t \leq 30 \text{ then CPR} = \frac{6\%\ t}{30}$$
$$\text{if } t > 30 \text{ then CPR} = 6\%$$

where t is the number of months since the mortgage originated.

Slower or faster speeds are then referred to as some percentage of PSA. For example, 90 PSA means 90% of the CPR of the PSA benchmark prepayment rate; 300 PSA means three times the CPR of the PSA benchmark prepayment rate. The CPR is converted to an SMM using equation (6). Table 3.1 shows the CPR and corresponding SMM by month for different PSA prepayment rates.

Constructing the Projected Cash Flow for a Mortgage Passthrough Security

Given our understanding of how to construct the cash flow of individual mortgage loans and measures of prepayment rates, we can construct a cash flow schedule for a mortgage passthrough security on the basis of some assumed prepayment rate (or rates). The computed cash flow is not only important for the analysis of mortgage passthrough securities but also for mortgage-related structures that have as their collateral a mortgage passthrough security or a pool of passthrough securities, such as collateralized mortgage obligations and stripped mortgage-backed securities.

Using underlining of a variable to denote a projected value, the formula to obtain the projected monthly mortgage payment for any month is:

$$\underline{MP}_t = \underline{MB}_{t-1}\left[\frac{i(1+i)^{n-t+1}}{(1+i)^{n-t+1}-1}\right] \tag{7}$$

where

$\underline{MP}_t$ = projected monthly mortgage payment for month t

$\underline{MB}_{t-1}$ = projected mortgage balance at the end of month t given prepayments have occurred in the past (which is the projected mortgage balance at the beginning of month t)

i = simple monthly interest rate (annual interest rate/12)

n = original term of the mortgage in months

To compute the portion of the projected monthly mortgage payment that is interest, the formula is:

$$\underline{I}_t = i\,\underline{MB}_{t-1} \tag{8}$$

where $\underline{I}_t$ = projected monthly interest for month t.

Equation (8) states that the projected monthly interest is found by multiplying the mortgage balance at the end of the previous month by the monthly interest rate. The projected monthly interest rate can be divided into two parts: (1) the projected net monthly interest after the servicing fee and (2) the servicing fee. The formulas are as follows:

$$\underline{NI}_t = \underline{MB}_{t-1}(i - s) \tag{9}$$

$$\underline{S}_t = s\,\underline{MB}_{t-1} \tag{10}$$

where

$\underline{NI}_t$ = projected interest net of servicing fee for month t
s = servicing fee and guaranty fee rate
$\underline{S}_t$ = projected servicing fee and guarantee fee for month t.

The projected monthly scheduled principal payment is then calculated by reducing the projected monthly mortgage payment by the projected monthly interest. In terms of our notation,

$$\underline{SP}_t = \underline{MP}_t - \underline{I}_t \tag{11}$$

where SP_t = projected monthly scheduled principal payment for month t.

The projected monthly principal prepayment is found by multiplying the SMM by the difference between the outstanding balance at the beginning of the month (the ending balance in the previous month) and the projected scheduled principal payment for the month. That is,

$$\underline{PR}_t = \mathrm{SMM}_t(\underline{MB}_{t-1} - \underline{SP}_t)$$

where

$\underline{PR}_t$ = projected monthly principal prepayment for month t
SMM_t = assumed single monthly mortality rate for month t

The cash flow to the investor is then the sum of (1) the projected monthly interest net of the servicing and guaranty fees, (2) the projected monthly scheduled principal payment, and (3) the projected monthly principal prepayment. That is,

$$\underline{CF}_t = \underline{NI}_t + \underline{SP}_t + \underline{PR}_t \tag{12}$$

where $\underline{CF}_t$ = projected cash flow for month t.

Alternatively, formula (12) can be expressed as:

$$\underline{CF}_t = \underline{I}_t + \underline{SP}_t + \underline{PR}_t - \underline{S}_t$$

Illustration

We can now illustrate the equations above[4] using the following hypothetical agency mortgage passthrough security backed by fixed-rate mortgages with a WAC of 8.125%, servicing and guaranty fee of 0.65 (65 basis points), a WAM of 357 months, and a par value of $400 million. We will assume a prepayment rate of 165 PSA.

Table 3.2 shows the cash flow for this hypothetical agency mortgage passthrough security. Below we explain each column.

- *Column 1*: This is the month number showing the cash flow projected for an investor who just purchased the security. There are 357 months of cash flow because the WAM is seasoned for three months (i.e., has already made three cash flow payments). For the purpose of applying the equations above, the first month is month 4 in terms of the PSA rate (i.e., $t = 4$).
- *Column 2*: The outstanding mortgage balance at the beginning of the month is equal to the outstanding balance at the beginning of the preceding month reduced by the total principal payment in the preceding month.
- *Column 3*: The single monthly mortality rate (SMM) assuming 165 PSA. Table 3.1 shows the SMM assuming 165 PSA for each month. Notice that for month 1 which is $t = 4$ in terms of the cash flow, the SMM is 0.00111 in Table 3.2 which agrees with the value shown in Table 3.1.

[4] In the formulas we develop above, the mortgage balance at the beginning of the month given prepayments that have occurred in the past must first be determined. The following formulas can be used to calculate the projected cash flow without knowing the mortgage balance at the beginning of the month. To do so, it is first necessary to introduce the following concept:

$$\text{Let } \underline{b}_t = (1 - \text{SMM}_t)(1 - \text{SMM}_{t-1}) \cdots (1 - \text{SMM}_2)(1 - \text{SMM}_1)$$

where b_t is the projected mortgage balance in month t per $1 of the original mortgage given prepayments through month t. Then, the projected monthly mortgage payment in month t is

$$\underline{MP}_t = \underline{b}_{t-1} MP$$

where MP = monthly mortgage payment on the original principal, assuming no prepayments. The projected scheduled principal payment is found as follows:

$$\underline{SP}_t = \underline{b}_{t-1} P_n$$

where P_t = scheduled principal payment on the original balance, assuming no prepayments. See the appendix to Lakhbir S. Hayre and Cyrus Mohebbi, "Mortgage Pass-Through Securities," in Frank J. Fabozzi (ed.), *Advances and Innovations in the Bond and Mortgage Markets* (Chicago: Probus Publishing, 1989), 259–304.

Table 3.2 Monthly cash flow for a $400 million mortgage passthrough security with a 7.5% coupon rate with a WAC of 8.125% and a WAM of 357 months assuming 165 PSA

(1) Month	(2) Outstanding Balance (MB_{t-1})	(3) SMM (SMM_t)	(4) Mortgage Payment (MP_t)	(5) Interest (I_t)	(6) Scheduled Principal (SP_t)	(7) Prepayment (PR_t)	(8) Total Principal	(9) Total Cash Flow (CF_t)
1	400,000,000	0.00111	2,975,868	2,500,000	267,535	442,389	709,923	3,209,923
2	399,290,077	0.00139	2,972,575	2,495,563	269,048	552,847	821,896	3,317,459
3	398,468,181	0.00167	2,968,456	2,490,426	270,495	663,065	933,560	3,423,986
4	397,534,621	0.00195	2,963,513	2,484,591	271,873	772,949	1,044,822	3,529,413
5	396,489,799	0.00223	2,957,747	2,478,061	273,181	882,405	1,155,586	3,633,647
6	395,334,213	0.00251	2,951,160	2,470,839	274,418	991,341	1,265,759	3,736,598
7	394,068,454	0.00279	2,943,755	2,462,928	275,583	1,099,664	l,375,246	3,838,174
8	392,693,208	0.00308	2,935,534	2,454,333	276,674	1,207,280	1,483,954	3,938,287
9	391,209,254	0.00336	2,926,503	2,445,058	277,690	1,314,099	1,591,789	4,036,847
10	389,617,464	0.00365	2,916,666	2,435,109	278,631	1,420,029	1,698,659	4,133,769
11	387,918,805	0.00393	2,906,028	2,424,493	279,494	1,524,979	1,804,473	4,228,965
12	386,114,332	0.00422	2,894,595	2,413,215	280,280	1,628,859	1,909,139	4,322,353
13	384,205,194	0.00451	2,882,375	2,401,282	280,986	1,731,581	2,012,567	4,413,850
14	382,192,626	0.00480	2,869,375	2,388,704	281,613	1,833,058	2,114,670	4,503,374
15	380,077,956	0.00509	2,855,603	2,375,487	282,159	1,933,203	2,215,361	4,590,848
16	377,862,595	0.00538	2,841,068	2,361,641	282,623	2,031,931	2,314,554	4,676,195
17	375,548,041	0.00567	2,825,779	2,347,175	283,006	2,129,159	2,412,164	4,759,339
18	373,135,877	0.00597	2,809,746	2,332,099	283,305	2,224,805	2,508,110	4,840,210
19	370,627,766	0.00626	2,792,980	2,316,424	283,521	2,318,790	2,602,312	4,918,735
20	368,025,455	0.00656	2,775,493	2,300,159	283,654	2,411,036	2,694,690	4,994,849
21	365,330,765	0.00685	2,757,296	2,283,317	283,702	2,501,466	2,785,169	5,068,486
22	362,545,596	0.00715	2,738,402	2,265,910	283,666	2,590,008	2,873,674	5,139,584
23	359,671,922	0.00745	2,718,823	2,247,950	283,545	2,676,588	2,960,133	5,208,083
24	356,711,789	0.00775	2,698,575	2,229,449	283,338	2,761,139	3,044,477	5,273,926
25	353,667,312	0.00805	2,677,670	2,210,421	283,047	2,843,593	3,126,640	5,337,061
26	350,540,672	0.00835	2,656,123	2,190,879	282,671	2,923,885	3,206,556	5,397,435
27	347,334,116	0.00865	2,633,950	2,170,838	282,209	3,001,955	3,284,164	5,455,002
28	344,049,952	0.00865	2,611,167	2,150,312	281,662	2,973,553	3,255,215	5,405,527
29	340,794,737	0.00865	2,588,581	2,129,967	281,116	2,945,400	3,226,516	5,356,483
30	337,568,221	0.00865	2,566,190	2,109,801	280,572	2,917,496	3,198,067	5,307,869
. . .								
100	170,142,350	0.00865	1,396,958	1,063,390	244,953	1,469,591	1,714,544	2,777,933
101	168,427,806	0.00865	1,384,875	1,052,674	244,478	1,454,765	1,699,243	2,751,916
102	166,728,563	0.00865	1,372,896	1,042,054	244,004	1,440,071	1,684,075	2,726,128
103	165,044,489	0.00865	1,361,020	1,031,528	243,531	1,425,508	1,669,039	2,700,567
104	163,375,450	0.00865	1,349,248	1,021,097	243,060	1,411,075	1,654,134	2,675,231
105	161,721,315	0.00865	1,337,577	1,010,758	242,589	1,396,771	1,639,359	2,650,118
. . .								
200	56,746,664	0.00865	585,990	354,667	201,767	489,106	690,874	1,045,540
201	56,055,790	0.00865	580,921	350,349	201,377	483,134	684,510	1,034,859

202	55,371,280	0.00865	575,896	346,070	200,986	477,216	678,202	1,024,273
203	54,693,077	0.00865	570,915	341,832	200,597	471,353	671,950	1,013,782
204	54,021,127	0.00865	565,976	337,632	200,208	465,544	665,752	1,003,384
205	53,355,375	0.00865	561,081	333,471	199,820	459,789	659,609	993,080
. . .								
300	11,758,141	0.00865	245,808	73,488	166,196	100,269	266,465	339,953
301	11,491,677	0.00865	243,682	71,823	165,874	97,967	263,841	335,664
302	11,227,836	0.00865	241,574	70,174	165,552	95,687	261,240	331,414
303	10,966,596	0.00865	239,485	68,541	165,232	93,430	258,662	327,203
304	10,707,934	0.00865	237,413	66,925	164,912	91,196	256,107	323,032
305	10,451,827	0.00865	235,360	65,324	164,592	88,983	253,575	318,899
. . .								
350	1,235,674	0.00865	159,202	7,723	150,836	9,384	160,220	167,943
351	1,075,454	0.00865	157,825	6,722	150,544	8,000	158,544	165,266
352	916,910	0.00865	156,460	5,731	150,252	6,631	156,883	162,614
353	760,027	0.00865	155,107	4,750	149,961	5,277	155,238	159,988
354	604,789	0.00865	153,765	3,780	149,670	3,937	153,607	157,387
355	451,182	0.00865	152,435	2,820	149,380	2,611	151,991	154,811
356	299,191	0.00865	151,117	1,870	149,091	1,298	150,389	152,259
357	148,802	0.00865	149,809	930	148,802	0	148,802	149,732

- *Column 4*: The total monthly mortgage payment using equation (7).
- *Column 5*: The monthly interest determined by multiplying the outstanding mortgage balance at the beginning of the month by the security's coupon rate of 7.5% and dividing by 12. Note that this is the monthly interest and is the net interest since it is the coupon rate paid on the mortgage passthrough security. That is, the servicing and guaranty fees are already taken into account.
- *Column 6*: The regularly scheduled principal repayment which is the difference between the total monthly mortgage payment (the amount shown in column 4) and the gross coupon interest for the month. The gross coupon interest is 8.125% multiplied by the outstanding mortgage balance at the beginning of the month, then divided by 12.
- *Column 7*: The prepayment for the month is calculated using equation (4).
- *Column 8*: The total principal payment, which is the sum of columns 6 and 7, is shown.
- *Column 9*: The projected monthly cash flow is the sum of the interest paid to investors (column 5) and the total principal payments for the month (column 8).

To compare the impact of the prepayment rate on monthly prepayments and cash flow, Table 3.3 shows these values for 100 PSA and 165 PSA. Also shown in the table is the difference between the prepayments and cash flow of 165 PSA relative to 100 PSA.

Table 3.3 Monthly prepayments and cash flows for 100 PSA vs 165 PSA

	100 PSA		165 PSA		$ Difference relative to 100 PSA	
Month	Prepayment	Cash flow	Prepayment	Cash flow	Prepayment	Cash flow
1	267,470	3,035,005	442,389	3,209,923	174,919	174,918
2	334,198	3,100,020	552,847	3,317,459	218,649	217,439
3	400,800	3,164,447	663,065	3,423,986	262,265	259,539
4	467,243	3,228,252	772,949	3,529,413	305,706	301,161
5	533,493	3,291,401	882,405	3,633,647	348,912	342,246
6	599,514	3,353,860	991,341	3,736,598	391,827	382,738
7	665,273	3,415,597	1,099,664	3,838,174	434,391	422,577
8	730,736	3,476,577	1,207,280	3,938,287	476,544	461,710
9	795,869	3,536,769	1,314,099	4,036,847	518,230	500,078
10	860,637	3,596,140	1,420,029	4,133,769	559,392	537,629
11	925,008	3,654,658	1,524,979	4,228,965	599,971	574,307
12	988,948	3,712,291	1,628,859	4,322,353	639,911	610,062
13	1,052,423	3,769,010	1,731,581	4,413,850	679,158	644,840
14	1,115,402	3,824,784	1,833,058	4,503,374	717,656	678,590
15	1,177,851	3,879,583	1,933,203	4,590,848	755,352	711,265
16	1,239,739	3,933,378	2,031,931	4,676,195	792,192	742,817
17	1,301,033	3,986,139	2,129,159	4,759,339	828,126	773,200
18	1,361,703	4,037,840	2,224,805	4,840,210	863,102	802,370
19	1,421,717	4,088,453	2,318,790	4,918,735	897,073	830,282
20	1,481,046	4,137,952	2,411,036	4,994,849	929,990	856,897
21	1,539,658	4,186,309	2,501,466	5,068,486	961,808	882,177
22	1,597,525	4,233,501	2,590,008	5,139,584	992,483	906,083
23	1,654,618	4,279,503	2,676,588	5,208,083	1,021,970	928,580
24	1,710,908	4,324,290	2,761,139	5,273,926	1,050,231	949,636
25	1,766,368	4,367,841	2,843,593	5,337,061	1,077,225	969,220
26	1,820,970	4,410,133	2,923,885	5,397,435	1,102,915	987,302
27	1,874,688	4,451,144	3,001,955	5,455,002	1,127,267	1,003,858
28	1,863,519	4,426,879	2,973,553	5,405,527	1,110,034	978,648
29	1,852,406	4,402,736	2,945,400	5,356,483	1,092,994	953,747
30	1,841,347	4,378,715	2,917,496	5,307,869	1,076,149	929,154
...						
100	1,187,608	2,965,848	1,469,591	2,777,933	281,983	−187,915
101	1,179,785	2,949,052	1,454,765	2,751,916	274,980	−197,136
102	1,172,000	2,932,340	1,440,071	2,726,128	268,071	−206,212
103	1,164,252	2,915,712	1,425,508	2,700,567	261,256	−215,145
104	1,156,541	2,899,166	1,411,075	2,675,231	254,534	−223,935
105	1,148,867	2,882,703	1,396,771	2,650,118	247,904	−232,585
...						
200	562,651	1,639,219	489,106	1,045,540	−73,545	−593,679
201	557,746	1,628,980	483,134	1,034,859	−74,612	−594,121
202	552,863	1,618,790	477,216	1,024,273	−75,647	−594,517
203	548,003	1,608,650	471,353	1,013,782	−76,650	−594,868
204	543,164	1,598,560	465,544	1,003,384	−77,620	−595,176
205	538,347	1,588,518	459,789	993,080	−78,558	−595,438
...						

300	164,195	824,320	100,269	339,953	−63,926	−484,367
301	160,993	817,960	97,967	335,664	−63,026	−482,296
302	157,803	811,629	95,687	331,414	−62,116	−480,215
303	154,626	805,328	93,430	327,203	−61,196	−478,125
304	151,462	799,055	91,196	323,032	−60,266	−476,023
305	148,310	792,811	88,983	318,899	−59,327	−473,912
...						
350	18,334	539,356	9,384	167,943	−8,950	−371,413
351	15,686	534,286	8,000	165,266	−7,686	−369,020
352	13,048	529,238	6,631	162,614	−6,417	−366,624
353	10,420	524,213	5,277	159,988	−5,143	−364,225
354	7,801	519,209	3,937	157,387	−3,864	−361,822
355	5,191	514,228	2,611	154,811	−2,580	−359,417
356	2,591	509,269	1,298	152,259	−1,293	−357,010
357	0	504,331	0	149,732	0	−354,599

Cash Flow for an Agency Multi-Class MBS Structure

Once the projected cash flow for collateral is used to create an agency multi-class MBS structure, the cash flow for each bond class in a structure can be projected based on the rules for distribution of principal and interest to each bond class. Agency multi-class MBS include stripped MBS and CMOs.

In a stripped MBS, the subject of Chapter 18, all principal is distributed to one bond class, the principal-only (PO) bond class, and all of the interest to the other bond class, the interest-only (IO) bond class. So for the hypothetical mortgage passthrough security shown in Table 3.2, column (8), which shows the total principal based on 165 PSA, is the projected cash flow for the PO and column (5) the projected cash flow for the IO. If the assumed prepayment rate is 100 PSA rather than 165 PSA, the PO's cash flow is shown in Table 3.3.

In an agency CMO, there are bond classes where there are rules for the distribution of interest and principal to each bond class in the structure. We will see how the interest and principal are distributed in Chapter 12 where we explain CMOs.

Average Life

The **average life** of any type of MBS is the average time to receipt of principal payments. Since the principal payments include the sum of the scheduled principal payments which depends on the prepayment rate assumed and the prepayments projected, an average life cannot be computed without making some assumption about the prepayment rate.

Mathematically, the average life is expressed as follows:

$$\text{Average life} = \sum_{t=1}^{T} \frac{t \times \text{Projected principal received at month } t}{12\ (\text{Total principal})}$$

where T is the number of months.

The average life for the hypothetical mortgage passthrough security assuming 100 PSA is 11.66. At a faster prepayment rate, the average life will shorten. For our hypothetical security, for example, it will be 8.76 if the prepayment rate is assumed to be 165 PSA.

Key Points

- The projection of the cash flow of a mortgage-backed security depends on the assumed prepayment rate for the pool of loans backing the security.
- For a level-payment fixed-rate mortgage, the monthly mortgage payment includes (1) interest equal to one-twelfth of the fixed annual interest rate times the amount of the outstanding mortgage balance at the beginning of the month and (2) repayment of a portion of the outstanding mortgage balance (scheduled principal repayment).
- The difference between the monthly mortgage payment and the portion of the payment representing the monthly interest equals the amount that is applied to reduce the outstanding mortgage balance.
- The two major characteristics of this mortgage design are (1) the portion of the monthly mortgage payment applied to interest declines each month, and therefore the portion that goes to reducing the mortgage balance increases, and (2) after the last scheduled monthly mortgage payment is made, the amount of the outstanding mortgage balance is zero (i.e., the mortgage is fully repaid).
- In the case of an adjustable-rate mortgage, the teaser rate is used to determine the monthly mortgage payment. The monthly mortgage payment is recalculated at the coupon reset date using the coupon reset formula, taking into consideration any restrictions on the mortgage rate due to periodic and lifetime caps and floor.
- Because not all of the loans that are included in a pool of loans for an MBS have the same loan rate, a pool is described by gross weighted average coupon rate, or gross WAC, found by weighting the contract rate for each loan in the pool by the percentage of the outstanding loan balance relative to the outstanding loan balance of all the loans in the pool.
- The net WAC is computed by subtracting from the gross WAC the (1) servicing fee, (2) trustee fee, and (3) payment for credit support such as the guaranty fee.
- A loan pool's weighted average maturity (WAM) is calculated by weighting the remaining number of months to maturity for each loan in the pool by the amount of the outstanding loan balance.
- The weighted average remaining maturity (WARM) or weighted average remaining time (WART) is the WAM for the pool after the issuance date.
- For Freddie Mac and Ginnie Mae mortgage passthrough securities, the remaining number of months is reported each month and called the weighted average loan age (WALA).

- A measure similar to WALA to measure the remaining number of months for the underlying mortgages is reported by Fannie Mae for its mortgage passthrough security and is referred to as the calculated loan age (CAGE).
- A prepayment is the amount of the loan payment that is in excess of the scheduled principal payment and interest.
- A prepayment rate (or prepayment speed) is typically measured in terms of the single monthly mortality rate (SMM) with the corresponding annualized measure being the conditional prepayment rate (CPR).
- The Public Securities Association (PSA) standard prepayment benchmark is expressed as a series of monthly CPRs, which assumes that prepayment rates will be low for newly originated mortgages and then will speed up as the mortgages become seasoned. Slower or faster speeds are then referred to as some percentage of PSA.
- The cash flow for a mortgage passthrough security to the investor is the sum of (1) the projected monthly interest net of the servicing and guaranty fees, (2) the projected monthly scheduled principal payment, and (3) the projected monthly principal prepayment.
- The computed cash flow is not only important for the analysis of mortgage passthrough securities but also in mortgage-related structures (i.e., collateralized mortgage obligations and stripped mortgage-backed securities) that have as their collateral a mortgage passthrough security or a pool of passthrough securities.

CHAPTER 4

NEW REGULATIONS FOR SECURITIZATIONS AND ASSET-BACKED SECURITIES

SHARON BROWN-HRUSKA,
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After reading this chapter you will understand:

- the challenges asset-backed securities faced in the financial crisis of 2007–9;
- the Dodd-Frank Act's provisions authorizing new regulations of asset-backed securities and securitizations;
- the changes that SEC's Regulation AB-II made to rules governing the offering process, disclosure, and reporting for asset-backed securities;
- Credit Risk Retention Rule (i.e., "skin in the game") requirements for securitizations;
- Volcker Rule requirements targeting proprietary trading and exemptions preserving the securitization process;
- emerging rules governing credit derivatives on mortgage-backed securities, collateralized debt obligations, and synthetic collateralized debt obligations.

The financial crisis of 2007–9 revealed problems with underwriting standards in mortgage markets that spread to the mortgage-backed securities (MBS) and asset-backed securities (ABS) markets more broadly. In 2010, the US Congress passed the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act), which contained express provisions that sought to increase transparency in the market for securitized assets and to better align the incentives facing different classes of market participants. The resulting rulemaking extended beyond the securitization and offering process for the issuance of ABS, creating requirements for ongoing disclosures, some applying to ABS issuers,[1] and others to the credit rating agencies that periodically assess the credit quality of ABS and other fixed income assets. Other structured products, including collateralized debt obligations (CDOs) on MBS and ABS indices whose performance was based on pools of mortgages or other assets, credit derivatives, and broader classes of securities-based swaps and financial assets, were subjected to new requirements for posting margin, collateral, and clearing aimed at reducing contagion and systemic risk that characterized the crisis.

Challenges in the Asset-Backed Securities Markets in the Financial Crisis

Asset-backed securities are financial products created by the process of securitization, which consists of bundling loans into asset pools and then issuing securities backed by the cash flows of the pools of underlying loans.[2] During the 2007–9 financial crisis, mortgage-backed securities, or more specifically, residential mortgage-backed securities (RMBS), the subset of ABS collateralized by residential mortgages, and in particular those based on loans made to subprime borrowers, performed poorly. This led policymakers and financial publications to attribute substantial blame for the financial crisis to ABS markets and more broadly to securitization market participants.[3] Post-crisis assessments by government entities such as the Financial Crisis Inquiry Commission (FCIC) and the Securities and Exchange Commission (SEC) identified four key factors requiring redress: opaqueness with respect to the securitization of pools of loans into ABS;[4] the related reliance on credit ratings issued by a small number of credit rating agencies;[5] misaligned incentives among different parties in the securitization process;[6] and valuation and pricing challenges exacerbated by illiquidity[7] and uncertainty characterizing the ABS markets during the crisis.[8]

Throughout this chapter, examples may focus on MBS, but the processes, problems, and regulatory implications often also apply to the greater category of ABS.

[1] Issuers are also called arrangers or sponsors in some contexts.

[2] US Securities and Exchange Commission, "Asset-Backed Securities," October 23, 2014, available at <https://www.sec.gov/spotlight/dodd-frank/assetbackedsecurities.shtml>, accessed March 24, 2015.

[3] For example, the Financial Crisis Inquiry Commission Report blamed a "runaway mortgage securitization train" for having "lit and spread the flame of contagion and crisis." Financial Crisis Inquiry Commission, "The Financial Crisis Inquiry Report" (January 2011), xviii, xxiii.

[4] Financial Crisis Inquiry Commission, "The Financial Crisis Inquiry Report" (January 2011), 119–20.

[5] 75 FR 23328 (May 3, 2010), pp. 23330–1.

[6] Financial Crisis Inquiry Commission, "The Financial Crisis Inquiry Report" (January 2011), 165.

[7] Financial Crisis Inquiry Commission, "The Financial Crisis Inquiry Report" (January 2011), 234.

[8] Financial Crisis Inquiry Commission, "The Financial Crisis Inquiry Report" (January 2011), 228.

Market Opaqueness and Reliance on Credit Ratings

The securitization process transforms individual loans into marketable securities in several distinct steps. For MBS, for example, banks, trusts, and other lenders act as originators and begin the process by underwriting, funding, and servicing a loan to a mortgagor. In the next step, many such loans, often backed by similar underlying collateral types (e.g., residential mortgages), are purchased from originators by an arranger who bundles the underlying loans together into a pool. The arranger could be the Government National Mortgage Association (Ginnie Mae, a federal agency) or one of the government-sponsored enterprises (GSEs)—Freddie Mac and Fannie Mae—but could also be a private company. The arranger then sells the pool to a bankruptcy-remote special-purpose vehicle (SPV), which issues MBS backed by the SPV's pool of loans and sells them to investors. Nationally recognized statistical rating organizations (credit rating agencies) are engaged to issue credit ratings for the MBS, which are used to market the securities for sale. The securities are then purchased by pension funds, insurance companies, asset managers, or other investors.[9]

At each step of the securitization process, the potential for information asymmetry arises, since the purchaser may not have as much information regarding the assets in question as the seller. Moreover, the final investor is typically several degrees removed from origination of the underlying loans, adding to the potential difficulty in collecting all data relevant for performing due diligence.

One potential solution to the information asymmetry problem inherent to the securitization process could be for each purchaser in the chain to conduct independent due diligence on the underlying assets. Since building customized valuation models is time-consuming, costly, and requires investment in both data and labor,[10] however, this solution could involve repeating costly analysis several times. Compounding the information asymmetry, markets often move quickly, creating effective due diligence time constraints that require investors to collect and analyze relevant data in a short amount of time.

Brown-Hruska and Satwah opine that the high cost of independent due diligence on loan-level or asset-level information, market participants' increasing dependence on third-party sources, and the assumption that ABS assets were efficiently priced combined to create a kind of "Grossman–Stiglitz Paradox."[11] A Grossman–Stiglitz

[9] Adam B. Ashcraft and Til Schuermann, "Understanding the Securitization of Subprime Mortgage Credit," Staff Report No. 318, Federal Reserve Bank of New York (March 2008), 5–10.

[10] Sharon Brown-Hruska and Shuchi Satwah, "Financial Disclosure and SFAS 157: Seeking Transparency in a Perfect Storm," *Capital Markets Law Journal* 4/2 (2009), 148.

[11] Grossman and Stiglitz explored such a conundrum in a stylized model. See Stanford J. Grossman and Joseph E. Stiglitz, "On the Impossibility of Informationally Efficient Markets," *American Economic Review* 70/3 (June 1980), 393–408. For a description of the application of the Grossman–Stiglitz

Paradox occurs when incentives to invest in acquiring information about assets diminish as market prices are assumed to generally contain all relevant information. While the securitization process expanded the lending capacity of banks and issuers by passing credit risk to investors, the structural opacity and the cost of performing customized due diligence led some agents in the securitization process to rely upon the due diligence of third-party financial intermediaries and credit rating agencies better positioned to perform it.[12]

Given the challenges in conducting due diligence on securities supported by the cash flows of a pool of loans with potentially varied risk characteristics such as borrower credit score, collateral geography, or loan-to-value ratio, the SEC created principles-based disclosure requirements for ABS by adopting Regulation AB and publishing the rule in the Federal Register in 2005.[13] These disclosure requirements set minimum transparency and asset quality thresholds for so-called "shelf offerings" of ABS, which allow issuers to sell securities to the public without a separate prospectus for each offering in order to facilitate quicker access to capital markets.[14] This effectively allowed "off-the-shelf" offerings, as long as credit rating agencies assigned an "investment grade"[15] rating to the ABS and less than 20% of the underlying asset pool consisted of delinquent assets.[16]

Regulation AB in some ways incentivized the reliance on the due diligence of third parties, namely the credit rating agencies, as credit ratings were written into the regulatory requirements. Moreover, the SEC in 2010 opined that the shelf registration offering process in Regulation AB[17] did not require that issuers give prospective ABS investors sufficient time to conduct independent due diligence[18]—an opinion shared by the CFA Institute Centre for Financial Market Integrity and the Council of Institutional Investors, which both argued that investors did not always receive comprehensive prospectuses or other sources of information regarding ABS and their underlying collateral prior to making an investment decision.[19] Such cases were presented as potential obstacles to performing proper due diligence, because each ABS offering involved a new and unique security backed by a new and unique pool of underlying assets. In the absence of

Paradox to the financial crisis, see Brown-Hruska and Satwah, "Financial Disclosure and SFAS 157: Seeking Transparency in a Perfect Storm."

[12] Brown-Hruska and Satwah, "Financial Disclosure and SFAS 157: Seeking Transparency in a Perfect Storm," 148.

[13] 70 FR 1506 (January 7, 2005).

[14] 70 FR 1506 (January 7, 2005), pp. 1512–13.

[15] BBB– or better credit ratings, using S&P's ratings. Standard and Poor's, "Credit Ratings Definitions & FAQs" (2015), available at <https://web.archive.org/web/20150520063557><http://www.standardandpoors.com/ratings/definitions-and-faqs/en/us>, accessed May 27, 2015.

[16] 75 FR 23328 (May 3, 2010), pp. 23331–3.

[17] 70 FR 44722 (August 3, 2005), p. 44766.

[18] 75 FR 23328 (May 3, 2010), p. 23330.

[19] CFA Institute Centre for Financial Market Integrity and Council of Institutional Investors, *U.S. Financial Regulatory Reform: The Investors' Perspective* (July 2009), 12.

a detailed prospectus, this meant that primary market purchases of ABS could be conducted with buyers relying substantially on the assessments of credit rating agencies, since no specific prospectus supplement was required to be made available until days after the offering.[20]

Alignment of Incentives and Underwriting Standards

In the pre-crisis period, standard compensation practices at many financial institutions in the securitization process often incentivized volume over quality control. For example, originators and arrangers profited directly based upon volume, and faced market discipline if poor performance of underlying loans led to losses on their books. However, originators faced only the risk of delinquency or default before the loans could be sold to an arranger; arrangers faced only the risk of warehousing loans in their securitization pipelines before they put the loans into SPVs, issued ABS, and sold the ABS to investors. Some economists such as Markus Brunnermeier argued that, in essence, market discipline was transitory because a large portion of the credit risk was quickly transferred and ultimately borne by other parties.[21]

In an efficiently operating market, incentives are aligned via a combination of actual and predicted market signals such as price moves and reputational effects. In ABS markets, however, the limited nature of information available to final investors and the existence of multiple third parties throughout the securitization process meant that potential reputational damage was likely to be diffused, reducing the alignment of incentives among parties in the securitization process and final investors.

The FCIC concluded that the consequences of misaligned incentives were borne out by looser lending standards, a product of reduced due diligence by originators making the initial loans, arrangers who provided the immediate demand for purchasing most such loans, and ultimate investors who purchased ABS backed by the cash flows from such loans. The FCIC Report stated that in the lead up to the financial crisis:

> Lending standards collapsed, and there was a significant failure of accountability and responsibility throughout each level of the lending system. This included borrowers, mortgage brokers, appraisers, originators, securitizers, credit rating agencies, and investors, and ranged from corporate boardrooms to individuals. Loans

[20] CFA Institute Centre for Financial Market Integrity and Council of Institutional Investors, *U.S. Financial Regulatory Reform: The Investors' Perspective* (July 2009), 13. See also 17 CFR 230.424(b), April 1, 2006 edition.

[21] Markus K. Brunnermeier, "Deciphering the Liquidity and Credit Crunch 2007–08," NBER Working Paper No. 14612 (December 2008), 7.

were often premised on ever-rising home prices and were made regardless of ability to pay.[22]

Valuation Challenges and Contagion

Once doubts about the health of the housing market and the performance of the underlying assets surfaced, MBS valuation challenges became more pronounced. The declining performance of MBS heretofore considered "safe," coupled with rating downgrades, created sudden and substantial uncertainty in markets. Some economists suggested that the lack of transparency in the primary ABS market, misaligned incentives among different parties in the securitization process, and the reliance on credit rating agencies contributed to uncertainty regarding the value of MBS securities, which led to a reduction in liquidity for a wide range of ABS and ABS-linked products, including CDOs collateralized by MBS and credit default swaps (CDS) written on MBS.[23] This uncertainty-driven illiquidity in turn led to substantial declines in the prices for entire classes of products, including many well-performing MBS. As these assets formed a substantial portion of many financial firms' balance sheets, the price declines in entire classes of assets threatened the survival of many major firms. As the FCIC described the consequences:

> Through 2007 and into 2008, as the rating agencies downgraded mortgage-backed securities and CDOs, and investors began to panic, market prices for these securities plunged. Both the direct losses as well as the marketwide contagion and panic that ensued would lead to the failure or near failure of many large financial firms across the system.[24]

The failures of funds affiliated with major banks and ultimately several of the major banks themselves during the financial crisis raised questions about banks' proprietary trading activities in ABS, particularly MBS and structured products collateralized by MBS. The decline in confidence in MBS performance during the crisis also led to a substantial shift away from private-label mortgage securitizations by banks and toward agency issuances by GSEs. While agency MBS retain a government guarantee, investor credit risk is effectively restricted to the smaller non-agency category of MBS. As seen in Figure 4.1, the share of mortgage-related securities issued by non-agency sources fell from approximately half in 2006, just before the crisis, to a small fraction from 2008 through 2014.

[22] Financial Crisis Inquiry Commission, "The Financial Crisis Inquiry Report" (January 2011), 125.

[23] Gary B. Gorton, "Information, Liquidity, and the (Ongoing) Panic of 2007," NBER Working Paper No. 14649 (January 2009), 8–11.

[24] Financial Crisis Inquiry Commission, "The Financial Crisis Inquiry Report" (January 2011), 226.

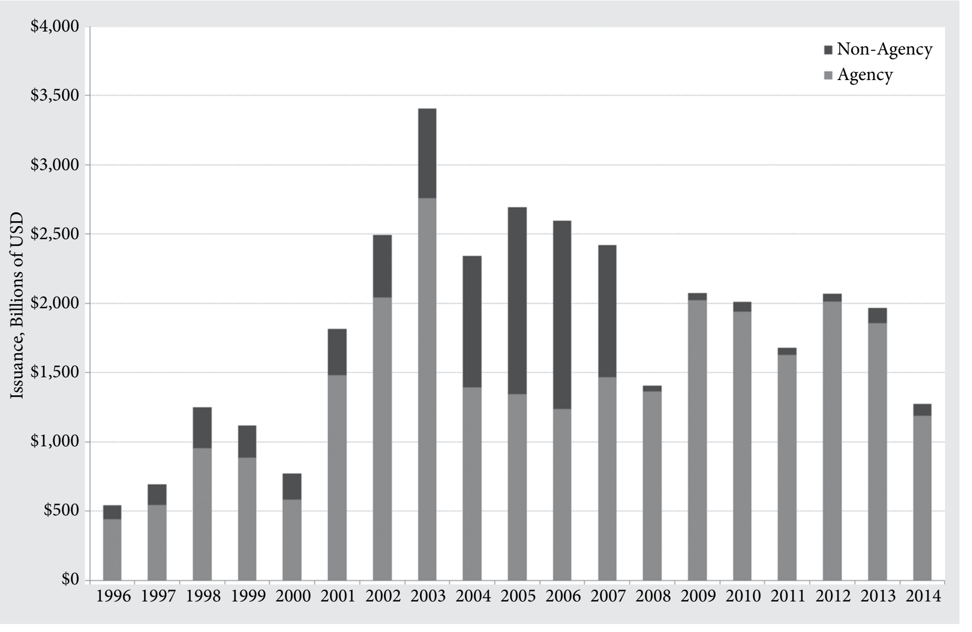

FIGURE 4.1 US mortgage-related securities issuance, 1996–2014

Note: Figures are annual. Agency securities include Fannie Mae, Freddie Mac, Ginnie Mae, and Federal Deposit Insurance Corporation/National Credit Union Administration issuances. Non-agency securities include MBS, home equity securities, and manufactured housing securities, as well as resecuritizations thereof.

Source: Data from Securities Industry and Financial Markets Association. Bloomberg, Dealogic, Thomson Reuters, U.S. Agencies, SIFMA. Reproduced with permission.

The Dodd-Frank Act and Other New Regulations Following the Financial Crisis

The size and scope of investor losses on MBS and other ABS created political pressure for substantial financial reform, which ultimately resulted in the passage of the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act) in July 2010.[25] This legislation authorized a substantial body of rules and regulations relating to ABS securitization, issuance, disclosure, and markets, including:[26]

[25] The Library of Congress, "Dodd-Frank Wall Street Reform and Consumer Protection Act Bill Summary & Status" (July 21, 2010), available at <http://thomas.loc.gov/cgi-bin/bdquery/z?d111:HR04173:@@@R>, accessed April 23, 2015.

[26] Those requirements specifically enumerated by the SEC on the SEC's Dodd-Frank Asset-Backed Securities page. Securities and Exchange Commission, "Asset-Backed Securities," available at <https://www.sec.gov/spotlight/dodd-frank/assetbackedsecurities.shtml>, accessed April 23, 2015.

- *Disclosures and Reporting for ABS Transparency and Due Diligence*: Section 942 required the SEC to create rules setting standards for ABS data disclosures that would allow investors to independently perform due diligence, and to require ABS issuers to disclose asset-level or loan-level data, including compensation information for the broker or originator of underlying assets, the amount of risk retention by the originator and the securitizer of such assets, and unique identifiers relating to loan brokers and originators for each asset.[27]
- *Credit Risk Retention Rules*: Section 941 required regulatory agencies to create credit risk retention rules in order to ensure that securitizers retained an economic interest in a portion of the credit risk for any ABS issued and sold to a third party.[28]
- *Volcker Rule*: Section 619 required that federal financial regulatory agencies create rules prohibiting banking entities from engaging in proprietary trading or from acquiring or retaining an ownership interest in or sponsoring hedge funds or private equity funds, unless allowed by specific exceptions. As securitization activities can appear similar to proprietary trading, banking entities require exemptions and exceptions to the Volcker Rule to continue issuing ABS. Regulators were left with substantial discretionary authority to interpret the statutory requirements when crafting the exemptions and exceptions in the implementing regulations.[29]
- *Due Diligence Analysis and Disclosure in ABS Issues*: Section 945 required that the SEC create rules that require ABS issuers to perform a review of the assets underlying the ABS and to disclose the nature of the review in the registration statement required to be filed pursuant to ABS issuance.[30]
- *Disclosures of Representations, Warranties, and Enforcement Mechanisms Available to Investors*: Section 943 required that the SEC create regulations mandating that credit rating agencies include in credit rating reports descriptions of representations, warranties, and enforcement mechanisms available to investors, including how they differ from the mechanisms in similar ABS; and mandating that securitizers disclose fulfilled and unfulfilled repurchase requests across all trusts aggregated by the securitizer, such that investors could identify asset originators with underwriting deficiencies.[31]
- *Conflict of Interest Restrictions*: Section 621 placed restrictions on ABS underwriters, placement agents, initial purchasers, sponsors, and affiliates and subsidiaries thereof engaging in transactions that would result in a material conflict of interest

[27] US Government Printing Office, "Dodd-Frank Wall Street Reform and Consumer Protection Act," Public Law 111-203, Section 942.
[28] US Government Printing Office, "Dodd-Frank Wall Street Reform and Consumer Protection Act," Public Law 111-203, Section 941.
[29] US Government Printing Office, "Dodd-Frank Wall Street Reform and Consumer Protection Act," Public Law 111-203, Section 619.
[30] US Government Printing Office, "Dodd-Frank Wall Street Reform and Consumer Protection Act," Public Law 111-203, Section 945.
[31] US Government Printing Office, "Dodd-Frank Wall Street Reform and Consumer Protection Act," Public Law 111-203, Section 943.

with respect to any investor in a transaction relating to the ABS for a year after the initial sale of the ABS.[32]

Financial regulators were authorized by these and other sections of the Dodd-Frank Act to issue rules and regulations substantially altering the typical ABS securitization process and related disclosures, generally with the aim of aligning the incentives of ABS issuers and investors and increasing market transparency in order to facilitate independent due diligence by investors.

Some of the most substantial regulatory changes following the financial crisis were the product of coordinated rulemaking by multiple regulatory bodies, including the SEC, the Office of the Comptroller of the Currency (OCC), the Federal Reserve, the Federal Deposit Insurance Corporation (FDIC), the Federal Housing Finance Agency (FHFA), and Department of Housing and Urban Development (HUD). Such coordinated rulemaking included the Credit Risk Retention Rule, which implemented Section 941 of the Dodd-Frank Act's requirements that securitizers of ABS retain an economic interest in the credit risk of the assets collateralizing the ABS,[33] and the so-called "Volcker Rule," implementing Section 619 of the Dodd-Frank Act's restrictions on proprietary trading by banking entities.[34]

In addition to such coordinated rulemaking, the SEC implemented ABS-specific disclosure and registration requirements via Regulation AB-II, which generally created underlying asset-level disclosure requirements for ABS offerings and reporting in order to increase ABS market transparency to investors. Several of these new rules are covered in the following sections.

Regulation AB-II

As briefly discussed above, in early 2005, the SEC published Regulation AB, which was intended to address the registration, disclosure, and reporting requirements for ABS. The principles-based set of disclosure items attempted to identify disclosure concepts and provide illustrative examples without creating detailed disclosure guides for each asset class.[35] In practice, however, this created substantial ambiguity as to what disclosures were required.

[32] US Government Printing Office, "Dodd-Frank Wall Street Reform and Consumer Protection Act," Public Law 111-203, Section 621, available at <http://www.gpo.gov/fdsys/pkg/PLAW-111publ203/html/PLAW-111publ203.htm>, accessed April 23, 2015.

[33] 79 FR 77602, "Credit Risk Retention" (December 24, 2014).

[34] 79 FR 5536, "Prohibitions and Restrictions on Proprietary Trading and Certain Interests in, and Relationships with, Hedge Funds and Private Equity Funds" (January 31, 2014). See also 79 FR 5223, "Treatment of Certain Collateralized Debt Obligations Backed Primarily by Trust Preferred Securities with Regard to Prohibitions and Restrictions on Certain Interests in, and Relationships with, Hedge Funds and Private Equity Funds" (January 31, 2014).

[35] 70 FR 1506, "Asset-Backed Securities" (January 7, 2005).

In principle, Regulation AB required that issuers disclose information including:

- a transaction summary and risk factors;
- static pool information on a sponsor's prior securitized pools of the same asset type, including delinquencies, cumulative losses, and prepayments;
- relevant details of the underlying asset pool;
- significant obligors of pool assets;
- the structure of the ABS transaction;
- derivatives instruments, such as swaps, altering the payment characteristics of the cash flows from the issuing entity; and
- credit ratings.

In practice, however, the SEC eventually concluded that the latitude granted to issuers in determining the materiality of required disclosures, as well as the ability to delay providing required disclosures until two business days after the first sale of securities in an ABS offering, combined to create a situation in which prospective investors may not have had access to all desired information to conduct independent due diligence, and may have lacked time to adequately review the ABS transaction.[36]

Following the financial crisis, regulators began proposing changes to Regulation AB designed to address the perceived shortcomings in ABS offering disclosures and overall ABS transparency to investors. In September 2014, the SEC published a final rule adopting substantial revisions to Regulation AB. This rule became known as Regulation AB-II, and mandated substantial additional disclosure requirements for ABS. Notably, however, Regulation AB-II did not expand the scope of applicable securities covered by the regulation: only registered public offerings of ABS are covered by Regulation AB-II, and other ABS, such as private placements under the provisions of Rule 144A, are not covered.[37] In addition, Regulation AB-II only applies to private-label securitizations, and does not apply to agency securitizations by the GSEs such as Fannie Mae and Freddie Mac, whose principal and interest are guaranteed while they remain under conservatorship.[38]

New Asset-Level Disclosure Requirements

Asset-level disclosure requirements were one of the more substantial changes to the ABS offering process and post-issuance market transparency. Regulation AB-II required that issuers provide asset-level data in a standardized format[39] at the time of offering and on an ongoing basis. This asset-level data was required to include:[40]

[36] 79 FR 57184, "Asset-Backed Securities Disclosure and Registration" (September 24, 2014), pp. 57188–9.
[37] 79 FR 57184, "Asset-Backed Securities Disclosure and Registration" (September 24, 2014).
[38] 79 FR 57184, "Asset-Backed Securities Disclosure and Registration" (September 24, 2014), p. 57193.
[39] XML format in the rule, 79 FR 57184 at pp. 57187–8.
[40] 79 FR 57184, "Asset-Backed Securities Disclosure and Registration" (September 24, 2014), pp. 57187–8.

- data regarding the payment streams related to particular assets underlying an ABS, such as contractual terms, scheduled payment amounts, basis for interest rate calculations, and how payment terms change over time, if applicable;
- collateral-specific data, such as geographic location, property valuation data, and loan-to-value ratio;
- performance data for each asset, such as information about obligor payment timeliness, delinquency, or default;
- loss mitigation data on efforts by the servicer to collect amounts past due and losses that may pass on to investors;
- income and employment status verification for obligors;
- mortgage insurance coverage, if relevant; and
- lien position.

Such information was deemed important for facilitating independent investor due diligence, and consequently had to be included in the offering prospectus and in ongoing reports.

Asset-level data requirements apply to ABS collateralized by residential and commercial mortgages, auto loans and leases, debt securities, and resecuritizations of those asset classes; other classes of securitizations, such as those collateralized by consumer debts and student loans, were exempted from these requirements as regulators decided that the compliance costs to provide asset-level data would exceed benefits to investors.[41]

New Shelf-Registration Eligibility Requirements

Most public offerings of ABS are conducted through shelf offerings;[42] consequently, reforming the eligibility criteria for shelf offerings was a major component of Regulation AB-II. Changes in shelf eligibility requirements and provisions included:[43]

- requiring that the issuer file a preliminary prospectus with transaction- and asset-level information at least three days prior to the first sale of ABS in the offering, and requiring that any third-party due diligence reports, such as those of credit rating agencies, be filed at least five days prior to the first sale of ABS in the offering, in order to give investors more time to engage in their own due diligence;
- removing the previous "investment grade" credit rating requirement;

41 79 FR 57184, "Asset-Backed Securities Disclosure and Registration" (September 24, 2014), p. 57188.

42 Securities and Exchange Commission, "SEC Adopts Asset-Backed Securities Reform Rules" (August 27, 2014), available at <http://www.sec.gov/News/PressRelease/Detail/PressRelease/1370542776577>, accessed April 23, 2015.

43 79 FR 57184, "Asset-Backed Securities Disclosure and Registration" (September 24, 2014).

- requiring that the chief executive officer of the depositor certify the disclosure contained in the prospectus and the structure of the securitization at the time of each ABS offering;
- requiring a provision in the ABS transaction agreement calling for the review of underlying assets for compliance with the representations and warranties upon the occurrence of specific trigger events;
- requiring the inclusion of a dispute resolution provision in ABS transaction documents;
- requiring disclosure of investor requests to communicate with other investors in the ABS; and
- replacing the previous ABS shelf registration practice of filing a base prospectus and a later prospectus supplement for each takedown with the requirement that a single prospectus be filed for each takedown (though issuers have the option of instead filing a supplement to the preliminary prospectus highlighting material changes from the preliminary prospectus 48 hours prior to the first sale, subject to the Regulation AB-II asset-level disclosure requirements and timing requirements of both the initial prospectus and the supplements).

Notably, credit rating agency risk assessments are removed as a necessary criterion for shelf-offering eligibility. However, an SEC rule, published in the Federal Register in the same month as Regulation AB-II, recognized the common (and presumed continued) use of third-party due diligence services like credit rating agencies by ABS issuers. This rule, the Dodd-Frank Nationally Recognized Statistical Rating Organizations implementing regulation (NRSRO regulation), required that credit rating agencies publicly disclose findings and conclusions in a due diligence report made available to potential investors and any users of credit ratings at least five days prior to the first sale in the ABS offering, if this credit rating agency report is used in place of Form ABS-15G.[44] Form ABS-15G is generally required to be furnished by issuers at least two days prior to the first ABS sale, unless the issuer obtains a representation from a credit rating agency that it will publicly disclose its findings and conclusions; in this way the NRSRO regulation complements the Regulation AB-II disclosure requirements, which apply to issuers.[45]

There were also numerous detailed reporting requirements for ABS added as part of Regulation AB-II intended to facilitate ongoing due diligence by investors, such as:[46]

- including all investor communications related to investor rights under the ABS in Form 10-D filings;[47]

[44] 79 FR 55078, "Nationally Recognized Statistical Rating Organizations" (September 15, 2014), p. 55182.

[45] 79 FR 55078, "Nationally Recognized Statistical Rating Organizations" (September 15, 2014), p. 55182.

[46] 79 FR 57184, "Asset-Backed Securities Disclosure and Registration" (September 24, 2014).

[47] Form 10-D is used for distribution reports by asset-backed issuers. See Securities and Exchange Commission, "Form 10-D," available at <https://www.sec.gov/about/forms/form10-d.pdf>, accessed May 27, 2015.

- including descriptions of material changes in a sponsor's retained interest in Form 10-D for that reporting period;
- describing the role of each servicing party, as well as the 1122(d) servicing criteria applicable to each servicing party in Form 10-K;[48] and
- requiring servicers to disclose the occurrence of material instances of noncompliance (MINCs) with 1122(d) servicing criteria, any steps taken to remediate MINCs, and whether a MINC involved the assets of the specific securitization addressed in Form 10-K.

Draft Proposals Excluded from Final Regulation AB-II

Some proposals that appeared in earlier versions of the proposed Regulation AB-II were not included in the final rule after public comment on the associated compliance costs, including:[49]

- requiring ABS issuers to file a computer program modeling the flow of funds or "waterfall" provisions of the ABS to aid investors in monitoring ongoing performance; and
- expanding the scope of securities covered by the regulation to include Rule 144A, private securitizations, and other exempt ABS transactions, rather than just registered public offerings. As a result, generally only securities previously covered by Regulation AB are covered by Regulation AB-II.

Credit Risk Retention Rule

The enactment of the Dodd-Frank Act put a hold on the SEC's independent efforts to create a shelf eligibility requirement for ABS issuers, mandating that they retain an economic interest (i.e., "skin in the game") in each tranche of an ABS offering in order to better align the incentives of all participants in the securitization process with those of final investors in ABS. Instead, the SEC, OCC, Federal Reserve, FDIC, FHFA, and HUD coordinated rulemaking and jointly proposed a Credit Risk Retention Rule, which was published in the Federal Register in April 2011.[50]

[48] Regulation AB required that firms filing Form 10-K annual reports with the SEC must include as exhibits reports from each party participating in the servicing function for ABS that assess compliance with a list of servicing criteria.

[49] 79 FR 57184, "Asset-Backed Securities Disclosure and Registration" (September 24, 2014), pp. 57190–1.

[50] 76 FR 24090, "Credit Risk Retention" (April 29, 2011).

Following several comment periods, the regulators published the coordinated final rule in the Federal Register in December 2014.[51] In terms of scope, the rule applied to all Exchange Act ABS,[52] whether or not such securities are offered publicly. The rule clarified the options available to ABS issuers for retaining at least 5% of aggregate credit risk and exemptions to the requirements.[53]

Standard Risk Retention

The Credit Risk Retention Rule's standard risk retention options—applicable to those offerings not eligible for exemptions or exceptions—were designed to be conceptually simple yet flexible. They allowed ABS sponsors to structure their minimum 5% credit risk retention "vertically" via equal shares of each tranche, "horizontally" via a first-loss piece equivalent to 5% of fair value of the underlying assets, or via an "L-shaped" customized combination of both vertical and horizontal retentions.

Eligible Vertical Retained Interest. The simplest compliance option consists of a vertical retained interest, in which a sponsor retains the same percentage of cumulative amount paid to all interests on each tranche of the ABS. Compliance can be achieved via either retention of the same percentage of each tranche of the ABS offered or a single vertical security with equivalent interest in amounts paid to each tranche, such that the total of the *par value* of the retained interest results in an overall exposure of 5% to the underlying asset pool's credit risk. Vertical retained interest is simple, transparent, aligns the interests of issuers with investors, and allows issuers to use the par value of their retained holdings to satisfy the requirement. As public comments submitted to regulators pointed out, however, by having issuers retain portions of typically lower-yielding senior tranches, it does prevent some of those safer and often more desirable ABS tranches from being sold to outside investors, and forces issuers to hold assets that may have a return below the issuer's cost of capital.[54]

Eligible Horizontal Residual Interest. The major conceptual alternative to holding vertical retained interest is to create a residual first-loss holding, which would allow issuers to signal increased creditworthiness in the more senior tranches by absorbing the first 5% of losses. This might increase investor participation. However, pure horizontal residual interest retention does not necessarily align issuers' incentives with all

[51] 79 FR 77602, "Credit Risk Retention" (December 24, 2014).

[52] Section 941 of the Dodd-Frank Act adds section 3(a)(77) to the Securities Exchange Act of 1934, and defines the term "asset-backed security" as "a fixed-income or other security collateralized by any type of self-liquidating financial asset . . . that allows the holder of the security to receive payments that depend primarily on cash flow from the asset. . . ."

[53] Some of these exemptions, for example, apply to government-sponsored enterprises, commercial mortgage-backed security issuers, and asset-backed commercial paper conduits.

[54] 79 FR 77602, "Credit Risk Retention" (December 24, 2014), p. 77720.

investors' incentives, since substantial losses on the underlying asset pool could eliminate the issuers' retained interest without impacting senior tranche investors. In this scenario, the issuer is left with fewer ongoing incentives to ensure effective future servicing of underperforming assets. As public comments noted, if the servicer is affiliated with the issuer, it could also lead to incentives to prefer loss mitigation approaches that favor junior tranches, such as loan modification, over approaches that favor senior tranches, such as liquidation of the securitized asset pursuant to uncertainty reduction.[55]

In order to better align issuer incentives with investor incentives, the rule requires that horizontal residual interest be measured by *fair value* rather than par value. This should tie the issuer's total economic exposure to the quality of the underlying pool of securitized assets. For low-quality asset pools, issuers would have to hold a larger residual tranche to meet the 5% fair value credit risk exposure requirement. For high-quality asset pools, the fair value of the residual tranche would be higher and issuers would be able to satisfy the requirement by holding a smaller residual interest.[56]

The rule also provides sponsors with the option of establishing an eligible horizontal cash reserve account in an amount equal to the fair value of a horizontal residual interest, in place of actually retaining a first-loss tranche. This reserve account would be used to satisfy payments on ABS interests or relevant expenses, thus fulfilling the same first-loss role as retaining an actual first-loss tranche.[57]

Eligible L-Shaped Interest. The Credit Risk Retention Rule allows sponsors to combine horizontal and vertical interests in any combination adding up to 5%, subject to the understanding that vertical interest is measured at par value and horizontal interest is measured at fair value. The regulators opined that such combinations can signal to investors that issuers' incentives are generally aligned with investors' across all tranches via the vertical interest component, while still allowing issuers to both signal confidence in the quality of the underlying asset pool and receive higher returns on capital on the first-loss horizontal interest component. Regulators allowed these L-shaped credit risk retentions in order to give issuers substantial flexibility in structuring their ABS offerings.[58]

[55] 79 FR 77602, "Credit Risk Retention" (December 24, 2014), pp. 77719–20.

[56] The regulators concluded that Generally Accepted Accounting Principles (GAAP) standards concerning fair value calculation methodologies were sufficient to prevent gaming of the requirement. 79 FR 77602, "Credit Risk Retention" (December 24, 2014), p. 77716.

[57] "In lieu of retaining all or any part of an eligible horizontal residual interest under paragraph (a) of this section, the sponsor may, at closing of the securitization transaction, cause to be established and funded, in cash, an eligible horizontal cash reserve account in the amount equal to the fair value of such eligible horizontal residual interest or part thereof," subject to conditions requiring treatment of the eligible horizontal cash reserve account on a first-loss basis. 79 FR 77602, "Credit Risk Retention" (December 24, 2014), p. 77742.

[58] 79 FR 77602, "Credit Risk Retention" (December 24, 2014), pp. 77720–1.

Special Risk Retention

In addition to the standard risk retention options available to ABS sponsors, the rule included options for exempted asset classes and structures, recognizing that some specific ABS types may already have effective credit risk retention requirements or otherwise align the incentives of ABS sponsors and investors.

Government-Sponsored Enterprises. ABS sponsored by Fannie Mae and Freddie Mac that receive a full guarantee while the firms remain under federal conservatorship are exempt from credit risk retention requirements. The investors in such securitizations are theoretically not exposed to credit losses, and the guarantee acts as an effective credit risk exposure for the government-sponsored issuers.[59]

Commercial Mortgage-Backed Securities. Sponsors of ABS transactions collateralized solely by commercial real estate loans and servicing assets, commonly called commercial mortgage-backed securities (CMBS), have the option of satisfying the risk retention requirement by having one or two third-party purchasers of "B-piece" eligible horizontal residual interest in the issuing entity, meaning that these third-party purchasers must hold an eligible horizontal residual interest in the issuing entity in the same form, amount, and manner as would be held by the sponsor under the standard risk retention requirement. If multiple third-party purchasers are involved, then each party's interest must be *pari passu* with the other parties' interests. Several conditions must be met if CMBS sponsors utilize the CMBS option, including:[60]

- each third-party purchaser must conduct an independent review of each securitized asset's credit risk, expected cash flows, collateral, and underwriting standards prior to the sale of the ABS;
- each third-party purchaser must be unaffiliated with any party to the CMBS transaction, including other investors, the special servicer, or originators of less than 10% of the underlying assets;
- each third-party purchaser must pay for their B-piece in cash, and may not finance the purchase from any other party to the CMBS transaction apart from other investors; and
- the purchase price paid by third-party purchasers for the B-pieces must be disclosed, so other investors can quantify the credit risk exposure of the B-piece buyers, and the resulting level of incentive alignment with other investors.

Asset-Backed Commercial Paper. Asset-backed commercial paper (ABCP) conduits are generally SPVs holding assets such as ABS, whose purchases thereof are financed by the issuance of commercial paper. Regulators recognized that if the ABS purchased by an ABCP conduit were issued with sponsors already retaining credit risk, then the

[59] 79 FR 77602, "Credit Risk Retention" (December 24, 2014), pp. 77725–6.
[60] 79 FR 77602, "Credit Risk Retention" (December 24, 2014), pp. 77723–5.

Credit Risk Retention Rule might effectively "double tax" ABCP conduits. In order to prevent such doubling of credit risk retention requirements, the rule created an exemption for ABCP conduits with 100% liquidity support from a regulated institution whose ABS interests were all purchased in initial issuances from sponsors who already retained credit risk per the rule.[61]

Open Market Collateralized Loan Obligations. Collateralized loan obligations (CLOs) are ABS generally collateralized by tranches of senior secured commercial loans or similar obligations, often of borrowers with lower credit quality or lacking credit ratings. Two major types of CLOs exist: balance sheet CLOs securitizing loans already held by an institution and its affiliates, and open market CLOs sponsored by an investment adviser acting as an asset manager by purchasing the assets comprising the underlying collateral pool on the secondary market.

Despite industry comments contending that open market CLOs differ from other ABS because CLO sponsors are investment advisers and not necessarily in the chain of title on the securitized assets, the regulators rejected a blanket exemption for open market CLOs. However, CLO sponsors/asset managers can satisfy the risk retention requirement by holding only "CLO-eligible" tranches for which each syndicated loan's[62] "lead arranger" retains at least 5% of the tranche's value for the duration of the loan. A syndicated loan member qualifies as lead arranger if its initial allocation is at least 20% of the aggregate principal balance, and the largest allocation taken by any member. CLO-eligible tranches are subject to other restrictions, such as the requirement that they carry separate voting rights, which commenters suggested would be administratively difficult to implement. Moreover, if a syndicated loan has no lead arranger, CLO managers holding such assets must abide by the standard risk retention options.[63]

Other Special Risk Retention Options. Sponsors of tender option bonds (TOBs) have two alternative options for risk retention, provided that sponsors ensure 100% liquidity protection and provide for a mechanism aligning sponsors' incentives with investors';[64] and sponsors of revolving pool securitizations collateralized by short-maturity assets such as credit card receivables or trade receivables typically retain a meaningful exposure to credit risk via what is known as the series subordinated seller's interest, which can count towards credit risk retention in place of the standard retention methods.[65]

[61] Regulators acknowledged that the exemption eligibility criterion requiring that all ABS interests be purchased in initial issuances might reduce liquidity in ABS secondary markets, but defended the requirement by noting that ABCP sponsors can only influence the terms of an ABS deal via initial issuance acquisitions, and also noted that ABCP conduit structures primarily relying on secondary ABS market purchases performed poorly during the financial crisis. 79 FR 77602, "Credit Risk Retention" (December 24, 2014), p. 77723.

[62] A syndicated loan is a structured credit arrangement provided by a group of lenders, with one lender, the "lead arranger," responsible for structuring, arranging, and administering the loan.

[63] 79 FR 77602, "Credit Risk Retention" (December 24, 2014), pp. 77726–30.

[64] 79 FR 77602, "Credit Risk Retention" (December 24, 2014), pp. 77730–1.

[65] 79 FR 77602, "Credit Risk Retention" (December 24, 2014), pp. 77721–2.

Other Exemption and Exception Criteria

In addition to the exemptions for GSE-sponsored issuances and the special risk retention options for broad asset classes, the rule also included specific exemptions for defined "qualifying" assets.

Qualified Residential Mortgages. The rule exempts from risk retention requirements any securitization collateralized entirely by qualified residential mortgages (QRMs), and defines a QRM as a qualified mortgage (QM) under the Truth in Lending Act. By adopting the preexisting QM standard, regulators did not incorporate separate credit history standards or loan-to-value requirements as earlier versions of the rule had suggested they might.[66]

Mortgage Loans Exempt from QM. The rule exempted securitizations collateralized by loans exempt from the QM "ability-to-repay" requirements, such as loans originating through community-focused lending programs. In addition, mortgage loans secured by three-to-four unit residential properties that meet the criteria for QM apart from being consumer credit transactions are also exempt from Credit Risk Retention Rule requirements.[67]

Qualifying Commercial Real Estate Loans. Securitizations collateralized entirely by qualifying commercial real estate (CRE) loans are exempt from risk retention requirements. In order to qualify for the exemption, a number of requirements must be met, including:[68]

- the underlying CRE assets must meet specific underwriting standards, such as amortization periods of 10–25 years for non-multifamily residential CRE loans or 10–30 years for multifamily residential CRE loans, and loan-to-value caps of 70% for first and junior loans and 65% for first-lien loans, with exceptions;
- the securitization transaction must be collateralized solely by CRE loans and servicing assets; and
- the securitization transaction must not permit reinvestment periods.

Other Criteria. Securitizations collateralized entirely by qualifying commercial loans are exempt from risk retention requirements;[69] likewise, auto loans meeting qualifying criteria are individually exempt from risk retention requirements if securitized.[70]

[66] 79 FR 77602, "Credit Risk Retention" (December 24, 2014), pp. 77737–9.
[67] 79 FR 77602, "Credit Risk Retention" (December 24, 2014), pp. 77739–40.
[68] 79 FR 77602, "Credit Risk Retention" (December 24, 2014), pp. 77679–83.
[69] 79 FR 77602, "Credit Risk Retention" (December 24, 2014), pp. 77678–9.
[70] 79 FR 77602, "Credit Risk Retention" (December 24, 2014), pp. 77683–5.

Blended Pools of Qualifying Assets. Sponsors may blend pools of qualifying automobile loans, qualifying commercial loans, or qualifying CRE loans with non-qualifying assets of the same class in order to receive up to a 50% reduction in the minimum required risk retention.[71]

Volcker Rule

Section 619 of the Dodd-Frank Act, colloquially known as the Volcker Rule due to former Federal Reserve Chairman Paul Volcker's personal appeals to lawmakers, generally prohibited any banking entity from engaging in proprietary trading or from acquiring or retaining an ownership interest in or otherwise sponsoring hedge funds or private equity funds (covered funds).

As industry commenters pointed out that issuing or making markets in ABS can be construed as proprietary trading, the Volcker Rule as implemented by the SEC, Federal Reserve, FDIC, and OCC has substantial implications for the ABS market. Of particular interest are the implications of restrictions on interests in covered funds and the applicability of exemptions to securitization structures and ABS-related special-purpose entities.

The SEC, Federal Reserve, FDIC, and OCC issued a joint final rule in January 2014.[72] Due to the necessity of using detailed judgments relating to specific asset types or specific transaction types in determining when banking activities constitute, for instance, market making as opposed to proprietary trading, however, the most important aspects of the Volcker Rule from the perspective of the ABS market were the exemptions to the broad prohibitions on proprietary trading.

Prohibitions on Covered Funds and Exemptions for Traditional Securitization Structures

The Volcker Rule prohibits banking entities from directly or indirectly acquiring or retaining an ownership interest in covered funds as principals; from sponsoring a covered fund, for instance by acting as a trustee, commodity pool operator (CPO), managing member, or general partner of a covered fund; or from being enabled to select the

[71] 79 FR 77602, "Credit Risk Retention" (December 24, 2014), p. 77736.

[72] 79 FR 5536, "Prohibitions and Restrictions on Proprietary Trading and Certain Interests in, and Relationships with, Hedge Funds and Private Equity Funds" (January 31, 2014), p. 5540.

trustees, managers, or a majority of directors of a covered fund, subject to exemptions and exceptions.[73]

The implications of these definitions of prohibited covered funds on ABS are potentially substantial, as the regulators recognized that many securitization issuers would be considered investment companies under the Investment Company Act of 1940, and hence covered funds under the rule, but for the use of exemptions. Securitizations utilizing the exemptions under section 3(c)(5) of the Investment Company Act would not be affected by the restriction on covered funds, but those utilizing section 3(c)1 or 3(c)7 would be, unless another exemption can be utilized instead.

In addition, collateralized loan notes and some insurance securitizations may involve CPOs that must register with the Commodity Futures Trading Commission (CFTC), and as such would be considered covered funds under the rule. Industry comments suggest the broad wording of the covered commodity pool definition will likely require clarification from either the CFTC or judicial rulings in order to determine whether certain securitization structures would be considered covered funds.

The rule includes several specific exclusions from the covered fund definition, some of which may be utilized by some banking-entity-controlled issuers currently relying on section 3(c)1 or 3(c)7 exemptions under the Investment Company Act. The exceptions include: foreign public funds, wholly owned subsidiaries (which are still subject to restrictions on proprietary trading), joint ventures (which are still subject to restrictions on proprietary trading), acquisition vehicles formed temporarily to effect a bona fide merger or acquisition, foreign pension or retirement funds, insurance company separate accounts, bank-owned life insurance, loan securitizations, qualifying ABCP conduits, qualifying covered bonds, Small Business Investment Company and public welfare investment funds, registered investment companies and excluded entities not

[73] 79 FR 5536, "Prohibitions and Restrictions on Proprietary Trading and Certain Interests in, and Relationships with, Hedge Funds and Private Equity Funds" (January 31, 2014), p. 5787.

The regulators' determinations regarding the scope of applicability of the covered funds restriction, meaning which funds banking entities are unable to acquire or retain interests in, or to sponsor, dictate the scale of the prohibition's implications.

The rule defines covered funds as:

- issuers that would be considered investment companies under the Investment Company Act of 1940 but for section 3(c)1 or 3(c)7; or
- commodity pools under section 1a(10) of the Commodity Exchange Act for which
  - the CPO claims an exemption under 16 CFR 4.7; or
  - the CPO is registered with the CFTC as a CPO, substantially all participation units of the pool are owned by qualified eligible persons under 17 CFR 4.7(a)(2) and 17 CFR 4.7(a)(3), and no public offering to persons ineligible under 17 CFR 4.7(a)(2) and 17 CFR 4.7(a)(3) has taken place; or
- covered foreign funds, defined as entities organized outside of the United States, whose ownership interests are offered and sold solely outside of the United States, and which raises money from investors primarily for the purpose of trading or investing in securities, which is sponsored by or had ownership interests owned by a banking entity under the laws of the United States or of any State.

relying on exclusions contained in section 3(c)1 or 3(c)7, and issuers in conjunction with FDIC receivership or conservatorship operations.[74]

Several of these exemptions may apply to some ABS issuers.

Wholly Owned Subsidiaries. The rule includes an exemption for intermediate entities in the securitization process that are wholly owned by a banking entity or an affiliate thereof.[75]

Loan Securitizations. Issuing entities for ABS are not considered covered funds, and thus are allowed under the Volcker Rule, if all of their assets or holdings are loans as defined in the rule, cash equivalent securities, securities received in lieu of debts from loans, interest rate or foreign exchange derivatives actively used to hedge loan risk, servicing rights, or special units of beneficial interest and collateral certificates issued by a qualifying loan securitization special-purpose entity to transfer to the issuing entity the economic risks and benefits of otherwise qualifying assets. Assets or holdings disqualifying an issuing entity from the loan securitization exception include securities (apart from cash equivalents or securities received in lieu of debts with respect to permitted loans) or derivatives (apart from interest rate or foreign exchange derivatives used to reduce loan risks).[76]

A noteworthy loan securitization exception eligibility restriction for ABS issuers is the restriction on holding securities other than cash equivalents and securities received in lieu of debts, as some forms of securitized assets could plausibly be described as securities under some facts and circumstances, and described as a loan (or lease, or extension of credit, or receivable) under other facts and circumstances.

Qualifying ABCP Conduits. Issuing entities for ABCP are not considered covered funds, and thus are allowed under the Volcker Rule, if they exclusively hold loans and other assets permitted under the loan securitization exception, or ABS purchased during an initial issuance and supported solely by assets qualifying for the loan securitization exception; issue ABS comprised of residual interest and securities with a legal maturity of 367 days or less; and are backed by a regulated liquidity provider committed to provide unconditional coverage in the event that the issuing entity must use funds to redeem maturing ABS holdings.[77]

[74] 79 FR 5536, "Prohibitions and Restrictions on Proprietary Trading and Certain Interests in, and Relationships with, Hedge Funds and Private Equity Funds" (January 31, 2014), pp. 5788–9.

[75] "Wholly owned" means no more than 5% of the entity's ownership interests may be held by employees or directors of the banking entity or its affiliate, and no more than 0.5% of the entity's outstanding ownership may be held by a third party for the purpose of establishing corporate separateness or bankruptcy concerns, with the banking entity or its affiliate owning all other outstanding ownership interests (at least 94.5% of the wholly owned subsidiary). 79 FR 5536, "Prohibitions and Restrictions on Proprietary Trading and Certain Interests in, and Relationships with, Hedge Funds and Private Equity Funds" (January 31, 2014), p. 5788.

[76] 79 FR 5536, "Prohibitions and Restrictions on Proprietary Trading and Certain Interests in, and Relationships with, Hedge Funds and Private Equity Funds" (January 31, 2014), p. 5788.

[77] 79 FR 5536, "Prohibitions and Restrictions on Proprietary Trading and Certain Interests in, and Relationships with, Hedge Funds and Private Equity Funds" (January 31, 2014), p. 5789.

Qualifying Covered Bonds. Entities owning or holding solely pools of loans or other assets that qualify for the loan securitization exception may issue debt obligations collateralized by that pool of assets provided that the payment obligations for those debt obligations are fully and unconditionally guaranteed by an entity meeting the definition of a foreign banking organization, and such entities will not be considered covered funds provided they are wholly owned subsidiaries of a foreign banking organization.[78]

Remaining Areas of Concern

Industry comments noted that the exceptions included in the rule generally did not apply to ABS-issuing entities holding securities and derivatives, which appears to force banking entities to liquidate any holdings in such ABS issuers. This substantially limits the ability of banking entities to hold interests in or sponsor issuers of structured products, such as synthetic ABS, CDOs, and CLOs holding securities or derivatives, and collateralized mortgage obligations (CMOs) holding MBS.

Synthetic ABS. Synthetic ABS by definition employ derivatives to imitate the performance of a pool of reference assets. Using derivatives, it is possible to gain exposure to the economic risks and benefits of the pool of reference assets without actually holding them. Under the rule, such synthetic exposures to loans would not qualify for an exception to the covered funds restrictions.[79]

CDOs and CLOs Collateralized by Securities or Derivatives. CDOs often hold pools of securities, such as other ABS, and as such would be considered covered funds under the rule. The rule suggests regulators intend to disallow banking entities from engaging in some types of resecuritization, such as the creation of CDOs collateralized by structured products, noting that such transactions are complicated, difficult to value, lack long histories of performance data, and performed poorly in the financial crisis. Moreover, regulators expressed concern that allowing ABS issuers to hold securities such as other ABS or derivatives in the underlying pool of assets collateralizing a new ABS offering could allow banking entities to avoid the prohibition on ownership interest in covered funds.

Similar concerns applied to issuers of CLOs, which sometimes hold bonds or ABS in addition to loans. Whereas a CLO issuer holding only loans in its underlying asset pool would qualify for the loan securitization exception, a CLO issuer holding securities such as bonds or ABS would not, and thus would be considered a covered fund.[80]

78 79 FR 5536, "Prohibitions and Restrictions on Proprietary Trading and Certain Interests in, and Relationships with, Hedge Funds and Private Equity Funds" (January 31, 2014), p. 5789.

79 79 FR 5536, "Prohibitions and Restrictions on Proprietary Trading and Certain Interests in, and Relationships with, Hedge Funds and Private Equity Funds" (January 31, 2014), p. 5688.

80 79 FR 5536, "Prohibitions and Restrictions on Proprietary Trading and Certain Interests in, and Relationships with, Hedge Funds and Private Equity Funds" (January 31, 2014), pp. 5686–8.

CMOs Backed by MBS. Issuers of CMOs holding MBS rather than mortgage loans would not qualify for an exception to the covered fund definition unless they qualified for exemptions under section 3(c)(5) of the Investment Companies Act, which would depend on the characteristics of the MBS held. The same regulatory concerns regarding resecuritizations apply to CMOs as to CDOs and CLOs.[81]

The rule generally classifies ABS issuers engaging in resecuritization of an underlying pool of ABS or other securities or creating ABS with synthetic exposure to a pool of assets via derivatives as covered funds under the Volcker Rule. In the absence of a specific exception or exemption, banking entities and their affiliates will not be able to acquire, retain, or sponsor such ABS issuers. This applies to some issuers not always immediately associated with securitization or structured products, such as issuers of covered bonds, since the exception in the rule only applies to covered bonds backed by foreign banking organizations.[82]

Developments in the Regulation of Credit Derivatives

By 2006, dealer banks had created ABX indices, which are indices of credit default swap (CDS) contracts referencing multiple tranches of MBS. Perhaps the most famous of these was the ABX.HE index, a credit derivative that referenced a basket of 20 subprime RMBS tranches. The introduction of ABX indices created a reasonably liquid and observable market pricing of subprime mortgage risk. Economists such as Gary Gorton suggested the widely observed sudden and substantial deterioration of the ABX.HE index during the financial crisis may have helped add to perceptions of uncertainty regarding the actual value of entire classes of related securitized assets.[83]

As a result of the poor performance of ABX indices like the ABX.HE index during the crisis, the entire class of credit derivatives referencing securitized products came under regulatory scrutiny. The Dodd-Frank Act and related rules have targeted credit derivatives, with substantial new compliance requirements. Major regulatory changes affecting credit derivatives have included the swaps pushout requirement, new margin and collateral requirements, and new clearing and disclosure requirements.

[81] 79 FR 5536, "Prohibitions and Restrictions on Proprietary Trading and Certain Interests in, and Relationships with, Hedge Funds and Private Equity Funds" (January 31, 2014), pp. 5686–8.

[82] 79 FR 5536, "Prohibitions and Restrictions on Proprietary Trading and Certain Interests in, and Relationships with, Hedge Funds and Private Equity Funds" (January 31, 2014), pp. 5696–7.

[83] Gary B. Gorton and Andrew Metrick, "Securitized Banking and the Run on Repo," NBER Working Paper No. 15223 (August 2009), 10–14.

Rules Related to Security-Based Swaps on ABS

Section 716 of the Dodd-Frank Act prohibited federal government assistance from being provided to any swaps entity with respect to any swap, security-based swap, or other activity of a swaps entity.[84] The Federal Reserve published an interim rule in June 2013[85] and a final rule in January 2014, entitled Regulation KK,[86] implementing Section 716's restrictions with a clarification on the definition of an insured depository institution.

Industry comments suggested that Regulation KK effectively barred banking entities that were also swap dealers, security-based swap dealers, major swap participants, or major security-based swap participants from access to FDIC deposit insurance or Federal Reserve credit facilities or discount windows unless such swap activities were pushed into separate affiliates not eligible for such assistance. As a result, Section 716 and its implementing Regulation KK have become colloquially referred to as the "swaps pushout rule."

The statute and final rule had a number of exceptions, including allowing insured depository institutions to use swaps to directly hedge risks, and to act as swaps entities for swaps or security-based swaps involving rates or reference assets permissible for investment by a national bank, other than acting as a swaps entity for non-cleared CDS. The rule treats uninsured US branches or agencies of foreign banks as insured depository institutions for the purposes of Section 716, and establishes a process whereby state member banks and uninsured state branches or agencies of foreign banks may request a transition period to conform with the swaps pushout rule.

As a result of the exemptions, the swaps pushout rule primarily applied to CDS indices such as ABX, uncleared CDS, many physical commodity swaps, total return swaps, and equity swaps. It remained controversial due to concerns that pushing swaps into uninsured affiliates would create obstacles to the resolution of a bankruptcy or other wind-down of a complex financial company.

In December 2014, the swaps pushout rule was substantially weakened by the enactment of the 2015 Consolidated and Further Continuing Appropriations Act, which contained an amendment to Section 716.[87] The so-called Lincoln Amendment limited the classes of swaps pushed out of insured depository institutions to structured finance

[84] US Government Printing Office, "Dodd-Frank Wall Street Reform and Consumer Protection Act," Public Law 111-203, Section 716, available at <http://www.gpo.gov/fdsys/pkg/PLAW-111publ203/html/PLAW-111publ203.htm>, accessed April 23, 2015.

[85] 78 FR 34545, "Prohibition Against Federal Assistance to Swaps Entities (Regulation KK)" (June 10, 2013).

[86] 79 FR 340, "Prohibition Against Federal Assistance to Swaps Entities (Regulation KK)" (January 3, 2014).

[87] Public Law No. 113-235, "Consolidated and Further Continuing Appropriations Act, 2015," Section 630.

swaps such as ABX and other CDS indices; in essence, swaps based on ABS or groups or indices of ABS like ABX.HE became the only swaps still covered by the updated swaps pushout rule. The amendment also tasked prudential regulators[88] with creating regulations allowing insured depository institutions to engage in structured finance swap activities if such swaps meet credit quality thresholds set by the prudential regulators, or if structured finance swaps are used to mitigate risks, providing some expectation of relief to the targeted class of credit derivatives.

New Margin and Collateral Requirements

Sections 731 and 764 of the Dodd-Frank Act require the CFTC and SEC to register swap dealers, major swap participants, security-based swap dealers, and major security-based swap participants, and adopt rules jointly imposing both capital requirements and initial and variation margin requirements. Section 761 of the Dodd-Frank Act defines security-based swaps to include single-name and narrow-based credit swaps and equity-based swaps, while Section 721 defines swaps to include broad-based credit swaps. Comment letters indicate credit derivatives related to ABS, such as CDS indices, are directly affected by the ultimate rules adopted, as are synthetic ABS.[89]

In September 2014, the CFTC and prudential regulators published proposed rules in the Federal Register that would require covered swap entities to post initial and variation margin for uncleared swaps. The proposed rule granted preferential treatment to cleared swaps and futures over uncleared swaps in the calculation of initial margin requirements, requiring a ten-day closeout assumption for uncleared swaps, versus a five-day closeout assumption for cleared swaps and a one-day closeout assumption for futures.[90] Public comments on the proposed rule noted that this longer closeout assumption will require counterparties for uncleared swaps to post additional initial margin, which usually must be held in assets with low expected returns likely below financial firms' cost of capital, imposing both opportunity costs and direct costs of carry.

Many comments on the proposed rule, such as the cost–benefit analysis by Brown-Hruska and Wagener, were critical of its potentially high costs and substantially preferential

[88] Under the Dodd-Frank Act, prudential regulators include the Federal Reserve Board, the Office of the Comptroller of the Currency, the Federal Deposit Insurance Corporation, the Farm Credit Administration, and the Federal Housing Finance Agency. US Government Printing Office, "Dodd-Frank Wall Street Reform and Consumer Protection Act," Public Law 111-203, Section 721.

[89] 79 FR 59898, "Margin Requirements for Uncleared Swaps for Swap Dealers and Major Swap Participants," October 3, 2014; 79 FR 57348, "Margin and Capital Requirements for Covered Swap Entities" (September 24, 2014).

[90] 79 FR 57348, "Margin and Capital Requirements for Covered Swap Entities" (September 24, 2014), p. 57374.

treatment for cleared swaps and futures relative to uncleared swaps.[91] As of May 2015, the regulators have yet to publish the final rules responding to public comments. If regulators adopt the proposed rule, the costs of some synthetic ABS and many common hedges for ABS may increase.

Rules Relating to Clearing and Disclosure

As the Dodd-Frank Act and related regulations pushed markets toward clearing swaps, regulations relating to clearing security-based swaps became increasingly important to the credit derivatives marketplace. In December 2012, the CFTC published a final rule requiring that North American and European untranched CDS indices be cleared pursuant to the rules of any eligible derivatives clearing organization.[92]

Expected Consequences of New Regulations for ABS

Since the financial crisis, the regulatory landscape for ABS has shifted dramatically, with a particular emphasis on enabling greater and earlier ABS transparency down to the asset level, encouraging independent investor due diligence of ABS pool assets, and aligning the incentives of ABS issuers and investors. In addition, efforts to reduce proprietary trading by banks via the Volcker Rule are likely to have substantial impacts on the ability of banking entities to securitize certain assets, such as resecuritizations and synthetic securitizations. Finally, derivatives regulation following the financial crisis may force banks to push security-based ABS activities out into uninsured affiliates; new margin and collateral requirements may raise costs associated with security-based swaps and incentivize the use of futures and cleared swaps over uncleared swaps; and some classes of CDS, including those on ABS indices, are now required to be cleared.

As was previously mentioned, more than 90% of US MBS issuance since 2008 has been agency MBS, and hence guaranteed by the US government. These guarantees have resulted in exemptions for agency MBS from several major regulations, including Regulation AB-II and the Credit Risk Retention Rule. However, as the government

[91] See, for instance, Sharon Brown-Hruska and Trevor Wagener, "Cost-Benefit Analysis of the CFTC's Proposed Margin Requirements for Uncleared Swaps" (December 2, 2014), available at <http://www.nera.com/content/dam/nera/publications/2014/NERA_Margin_Requirements_Uncleared_Swaps.pdf>, accessed April 23, 2015.

[92] 77 FR 74284, "Clearing Requirement Determination under Section 2(h) of the CEA" (December 13, 2012).

guarantees of agency MBS are, as of May 2015, limited to the period of government conservatorship of the relevant GSEs, a change in the conservatorship status of the GSEs may make credit risk concerns relevant to future agency MBS issuances, and thus lead to the elimination of these exemptions or further changes to the regulations governing MBS and related products.[93]

Key Points

- Regulators and policymakers identified a lack of pre-trade transparency, flawed and outsourced due diligence, and a failure to align sponsor and issuer incentives with investor incentives as major drivers of poor ABS performance in the financial crisis.
- Following the crisis, the Dodd-Frank Act, implementing regulations, and coordinated rulemaking by financial regulators began to reshape the market for ABS and related derivatives.
- The SEC's Regulation AB-II required asset-level disclosures by issuers, earlier disclosures in order to give investors more time to conduct independent due diligence, stricter criteria for shelf registration and offering eligibility, and a de-emphasis on the importance of credit ratings to discourage reliance on third-party valuations by ABS investors.
- The Credit Risk Retention Rule requires that most ABS issuers retain a 5% aggregate exposure to the credit risk of the assets collateralizing the ABS offering, via a vertical retention, horizontal residual retention, or a combination thereof.
- The Volcker Rule prohibited banking entities from engaging in proprietary trading or acquiring interests in, retaining interests in, or sponsoring covered funds such as hedge funds or private equity funds, with exceptions and exemptions for some traditional securitization structures, but not for resecuritizations or securitizations of derivatives.
- Derivatives regulations following the financial crisis included an expansive swaps pushout rule later statutorily amended to only force banking entities to push out security-based swaps such as ABX, other CDS indices, and other structured finance credit derivatives into uninsured affiliated entities.
- New proposed margin and collateral requirements for uncleared swaps and a mandate to clear certain classes of CDS, such as untranched North American and European corporate CDS, may increase costs of some synthetic ABS and of common hedges for ABS.
- Regulators have yet to take final action on all rulemaking proposals, so the status of ABS and credit derivatives is still subject to change based on how regulators respond to public comments.

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[93] 79 FR 57184, "Asset-Backed Securities Disclosure and Registration" (September 24, 2014), p. 57193.

CHAPTER 5

IMPACT OF THE CREDIT CRISIS ON MORTGAGE-BACKED SECURITIES

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After reading this chapter you will understand:

- the causes and extent of growth in the non-agency RMBS market until 2007;
- factors contributing to the crisis in the RMBS market that began in 2007;
- the key events of the financial crisis affecting mortgage-backed securities;
- the role of the government-sponsored enterprises (GSEs) in the mortgage origination and MBS markets, particularly during and just after the financial crisis;
- federal government policies and programs to support the US mortgage finance system during and after the crisis;
- how the mortgage finance system has changed as a result of the crisis.

The subprime crisis of 2007 and subsequent larger credit crisis had a dramatic, adverse impact on residential mortgage-backed securities (RMBS), particularly those backed by mortgages of lower credit quality. This chapter describes that crisis, the conditions that preceded it, and the evolution of the mortgage market during the ensuing, broader credit crisis and beyond. The appendix includes a chronology of key crisis events during 2007 and 2008.

Non-agency RMBS issuance collapsed in the latter half of 2007 as deteriorating conditions in the housing market and broader economy led to worsening mortgage performance and the withdrawal of financing for subprime mortgage originators. Subprime mortgage originators exited the market through bankruptcy, consolidation, and other means. The adverse conditions caused prices of RMBS to fall and declining prices were exacerbated by additional sales as some investors reduced their holdings.

The market for the subprime and Alt-A mortgages that backed many non-agency RMBS had expanded in the 1990s as changes to lending rules combined with policies that encouraged lending to lower income groups. Institutional changes and experience with refinancing made it easier for homeowners to take out equity as they also took advantage of lower interest rates. Consumers preferred borrowing against home equity because, unlike most forms of consumer debt, the interest on home equity loans was tax deductible and was usually at a lower nominal rate than personal loans or credit card advances. Rising home prices, falling interest rates, and new, innovative loans contributed to non-agency RMBS issuance exceeding that of agency passthroughs in 2005 and 2006.

Several factors contributed to the crisis that began in 2007, including a reliance on house price appreciation to support mortgage products, more accommodating underwriting standards, and a production process that relied on the ready availability of short-term financing. For mortgages with little equity, house price appreciation protected against the negative equity that leads to higher default rates. Many variable-rate mortgages had lower initial rates and relied on future house price appreciation to fund refinancings to keep mortgage costs within the borrowers' ability to pay. During the period preceding the crisis, changes in underwriting standards, allowing higher leverage, less documentation, and combinations of risk factors, resulted in riskier mortgages being originated. When house price appreciation stopped and turned negative, these recently produced, riskier loans were more likely to experience negative equity and result in defaults.

The reliance on leverage in mortgage origination and issuance also contributed to the crisis. Many mortgage originators relied on external financing for funds to make and process mortgages prior to selling them in securitizations. In addition, non-agency RMBS were held in investment vehicles or by entities that relied on leverage as well. When market conditions began to deteriorate, mortgage originators found that their sources of financing were unwilling to continue to extend credit, and their dependence on credit accelerated their exit. For RMBS investors, declines in RMBS prices and losses reduced equity and caused numerous investors to deleverage. Asset sales put further downward pressure on market prices and contributed to additional writedowns and asset dispositions.

With the collapse of non-agency RMBS issuance, the GSEs became the dominant vehicle for mortgage financing. The GSEs expanded their issuance in late 2007 and 2008 as non-agency issuance fell off. By mid-2008, as poor mortgage performance continued for both conforming and nonconforming mortgages, the GSEs' losses from portfolio assets and guarantees caused market participants to be concerned about their continued viability. The federal government placed the GSEs into conservatorship, allowing them to continue to facilitate financing for mortgages. Although the problems in the housing market began with subprime mortgages, from 2008 through 2011 the GSEs reported losses of about $215 billion from single-family credit guarantees while the investment portfolio, which included much of the exposure to subprime loans, generated about $2 billion in income.[1]

[1] W. Scott Frame, Andreas Fuster, Joseph Tracy, and James Vickery, "The Rescue of Fannie Mae and Freddie Mac," Staff Report No. 719, Federal Reserve Bank of New York (March 2015), 25; US Federal Housing Finance Agency, Conservator's Report on the Enterprises' Financial Performance, Fourth Quarter 2011, p. 9.

Throughout 2008 and into 2009, the US government enacted measures to support the housing market and reduce the number of foreclosures. These included mortgage modification programs aimed at keeping homeowners in their homes and avoiding default, many of which applied to loans owned or guaranteed by the GSEs or government entities. They also included actions to increase liquidity, such as the Federal Reserve's purchases of agency passthroughs and an expansion in the loans that the GSEs, FHA, and VA could purchase or guarantee.

As the housing market stabilized, policymakers refocused their attention on the role of the federal government in the housing market. As yet, however, there are few points of general consensus. Programs aimed at specific groups such as those provided by the FHA, VA, and USDA have found support from many commentators and are likely to continue. Broad-based market initiatives such as those undertaken by Fannie Mae and Freddie Mac have less support and will likely change. Whatever policies are eventually followed in the housing market, the experience under Fannie Mae and Freddie Mac has been that standardization in securitized mortgage contracts increases liquidity, and the housing market has benefitted from liquidity of the type provided by the TBA market for Ginnie Mae, Fannie Mae, and Freddie Mac passthrough securities.

The Evolution and Growth of the Non-Agency RMBS Market

Non-agency RMBS expanded as a way to finance new, riskier loans that were initially intended to provide access to mortgages for groups who could not meet the requirements of conforming loans. As described in the next two sections, a number of structural changes facilitated the creation of subprime and Alt-A loans. Changes in tax laws broadened the appeal of these products to a wider group of homeowners. Most of these loans were securitized by non-agency issuers in RMBS that relied on various types of credit enhancement to make the securities more attractive to investors.

Structural Innovation at Loan Level

Subprime mortgage lending and non-agency RMBS had been a growing segment of the mortgage market before the problems that arose in 2006–8. Removal of legal impediments, such as the federal pre-emption of state interest rate caps (1980) and removal of prohibitions on variable interest rates and balloon payments (1982), made it possible to

- Option ARMs (which can involve negative amortization)
- Hybrid ARMs (2/28, 3/27, 5/25, 10/20)
- Interest only (usually for the first 5 or 10 years)
- Second mortgages, including simultaneous seconds (second liens used to fund purchase of a home, concurrent with issuance of the first mortgage)
- High LTV (no/low down-payment)
- No/low documentation
- 40-year term
- High debt-to-income
- HELs/HELOCs as permanent financing

FIGURE 5.1 Loan types designed to ease mortgage qualification requirements

charge higher rates on riskier loans.[2] Changes during the 1990s and early 2000s in the application of the 1977 Community Reinvestment Act and other policies encouraged lending to low-income households.[3] Under the Federal Housing Enterprises Act of 1992, federal regulators set annual goals for the GSEs to assist low-, lower-, and moderate-income families.[4] In the 2000s, the GSEs were allowed to count purchases of securities backed by subprime and Alt-A loans toward the goals, although they had begun purchasing these loans prior to the change in regulations.[5]

These changes allowed and encouraged lenders to develop mortgage products with features that would be affordable for lower-income households such as lower down-payments, slower amortization, higher leverage, less debt service coverage, and less documentation. As a result, the loans had greater risk than traditional mortgage products. As the market for lending to non-prime and unconventional borrowers grew, so did the types of mortgage products available to the consumer. (See Figure 5.1.) These mortgage loan types, which became popular in the mid-2000s, were supported by the growing market for non-agency RMBS.

The new mortgage products were also attractive to homeowners who wanted to access the equity in their homes. The Tax Reform Act of 1986 made cash-out refinancing and home equity loans (second mortgages) a preferred method of consumer borrowing

[2] Souphala Chomsisengphet and Anthony Pennington-Cross, "The Evolution of the Subprime Mortgage Market," *Review*, Federal Reserve Bank of St. Louis (January/February 2006), 38.

[3] See, e.g., the Gramm-Leach-Bliley Act of 1999 and its implementing regulations.

[4] US Department of Housing and Urban Development, "U.S. Housing Market Conditions" (Summer 1998), Summary.

[5] John Weicher, "The Affordable Housing Goals, Homeownership and Risk: Some Lessons from Past Efforts to Regulate the GSEs," Federal Reserve Bank of St. Louis Conference on "The Past, Present, and Future of the Government-Sponsored Enterprises" (November 17, 2010), 10–11.

when it ended the mortgage deduction for consumer loan interest.[6] Rising house prices, lower interest rates, and changes in the ease of refinancing encouraged existing homeowners to take equity out of their homes, and to do so more frequently.[7] Increased competition among mortgage originators along with financial and technological innovations reduced the direct and indirect costs of refinancing between the 1980s and 1990s.[8] Homeowners' increased experience with refinancing made them more aware of the benefits and the process; both these trends contributed to an observed increased propensity for homeowners to refinance.[9] From 2000 through 2005, rising house prices and falling interest rates made it attractive to more homeowners to make a cash-out refinancing or to take out a home equity loan, many using these newer, riskier mortgage products.

Adjustable rate mortgages with low starting interest rates became a popular feature of subprime mortgages. By early 2006, nearly 80% of subprime loans securitized into non-agency RMBS were adjustable rate, many of these being 2/28 or 3/27 hybrid loans. Interest-only loans were common as well, accounting for 17% of securitized subprime loans in 2006.[10] Originators also showed a greater willingness to accept higher risk on multiple underwriting criteria, such as a bigger loan resulting in both a higher loan-to-value ratio and a higher debt-to-income ratio. Such combinations, known as "risk layering," presented underwriting challenges: even if the risk exposure of each factor individually was well understood, the effect of combined risks was more difficult to anticipate.

The flexibility and affordability of subprime and Alt-A loans attracted homeowners who had previously gravitated toward FHA-insured mortgages. In June 2006, the FHA share of originations was 3%, down from 9% in 2001.[11]

[6] Chomsisengphet and Pennington-Cross, "The Evolution of the Subprime Mortgage Market," 38.

[7] For example, see Alan Greenspan and James Kennedy, "Estimates of Home Mortgage Originations, Repayments and Debt on One-to-Four-Family Residences," Finance and Economic Discussion Series 2005-41 (Washington, DC: Board of Governors of the Federal Reserve System); Alan Greenspan and James Kennedy, "Sources and Uses of Equity Extracted from Homes," Finance and Economic Discussion Series 2007-70; and Amir Khandani, Andrew Lo, and Robert Merton, "Systemic Risk and the Refinancing Ratchet Effect," *Journal of Financial Economics* 108 (2013), 29–45.

[8] Paul Bennett, Richard Peach, and Stavros Peristiani, "Structural Change in the Mortgage Market and the Propensity to Refinance," *Journal of Money, Credit and Banking* 33/4 (November 2001), 957–8 provides a discussion of these changes and how they contributed to the increased speed at which homeowners refinanced during the 1990s compared to the 1980s.

[9] Bennett, Peach, and Peristiani, "Structural Change in the Mortgage Market and the Propensity to Refinance," 958.

[10] "ARMs Power the Subprime MBS Market in Early 2006," *Inside B&C Lending* (July 21, 2006), and LoanPerformance, both cited in the testimony of Sandra L. Thompson, Director Division of Supervision and Consumer Protection, Federal Deposit Insurance Corporation, on Mortgage Market Turmoil: Causes and Consequences, before the Committee on Banking, Housing, and Urban Affairs, US Senate, Room 538, Dirksen Senate Office Building (March 22, 2007), 1–6.

[11] First-lien originations by numbers of loans. Harriet Newberger, "FHA Lending: Recent Trends and their Implications for the Future," Federal Reserve Bank of Philadelphia (December 2011), 1.

Credit Enhancement and the Market for Non-Agency RMBS

As the agency market did for conforming loans, securitization provided a means to finance jumbo, subprime, and Alt-A mortgages. By the mid-2000s, most nonconforming single-family mortgage loan originations were being securitized in non-agency RMBS. Without the ability to provide a strong guarantee, such as that on securities guaranteed by Fannie Mae, Freddie Mac, and Ginnie Mae, non-agency RMBS relied on several methods of credit enhancement to create classes of RMBS that were protected from the credit risk of the underlying mortgage pool. Such enhancement mechanisms came from unrelated parties, or were part of the deal structure itself (or both). As such, they are referred to either as external or internal credit enhancements, respectively. Many of these mechanisms were developed originally in the late 1980s and early 1990s to facilitate the disposition of nonconforming residential mortgages and non-residential mortgages from thrift institutions, notably through the Resolution Trust Corporation (RTC).

One type of external enhancement is bond insurance.[12] This is a guarantee from an insurance company that principal and interest will be paid on insured tranches in the event that loan losses exceed internal credit enhancements such as overcollateralization and reserve funds. Bond insurers, so-called monoline insurers, provided this type of insurance and included Ambac, FGIC, FSA, MBIA, and XL Capital Assurance.

By far the most common internal credit enhancement mechanism for non-agency RMBS was the senior/subordinate structure. The ability to create senior and super-senior pieces designed to get paid preferentially allowed those tranches to receive AAA ratings, while the subordinated tranches would get paid only after most or all of the more senior tranches had been retired. Of course, as compensation, the mezzanine tranches—so-called "B-pieces"—offered a higher expected yield.

Non-agency RMBS also enhanced credit for some tranches by "overcollateralization" and "excess spread." Overcollateralization involves providing loan collateral with an aggregate principal amount greater than the aggregate par amounts of bonds in a deal, such that even the most subordinated bonds are able to withstand losses up to the amount of the overcollateralization. Excess spread is the difference between the interest rates on loan collateral and the coupon rates on the supported bonds. These funds can be used to offset interest shortfalls and principal losses.

Subordination was also combined with bond insurance to permit a higher ratio of AAA to lower-rated bonds in a deal.

[12] One of the oldest external mechanisms, now rarely used, is a bank letter of credit. This is a financial guarantee by the issuing bank stating that it promises to reimburse credit losses up to a predetermined amount.

The credit rating agencies, through the use of their internal models and historical data, determined the amount of subordination (in combination with other credit enhancements) required to achieve a particular rating. The criteria varied by mortgage type, borrower characteristics, originator, servicer, and other factors. As mortgage types proliferated, the rating agencies adapted their criteria to the new loan features and new combinations of risks (risk layering).

Non-Agency RMBS and CDOs

As in the market for conforming mortgages securitized in agency passthroughs, jumbo, subprime, and Alt-A originators periodically issued securities collateralized by their recent loan originations. Originators relied on short-term financing in order to make and hold loans between origination and securitization. This short-term financing could take many forms: repurchase agreements, lines of credit, or asset-backed commercial paper, for example. As a source of liquidity for originators, this financing was critical to the operation of the non-agency RMBS market.

Non-agency RMBS issuance grew rapidly from 2000 through 2006 (see Figure 5.2). In 2000, non-agency RMBS issuance was about 30% of agency passthrough issuance and by 2004, the proportions were approximately equal for the first time. In 2005 and again in 2006, issuance of non-agency RMBS was almost $1.2 trillion, exceeding agency passthrough issuance in both years. Subprime loans accounted for about $600 billion of the total each year.[13]

The growth of subprime and Alt-A mortgages was also aided by increasing use of the CDO structure. CDOs had been developed in the late 1980s and early 1990s primarily to aggregate corporate and emerging market bonds into pools, and thereby diversify their risks. In 2000, nearly all CDOs were backed by single-class bonds; only 2% of the $68 billion in CDOs issued that year were collateralized by structured finance securities. Five years later, a majority of new CDOs were backed by structured finance securities—predominately mezzanine tranches of non-agency RMBS. See Figure 5.3.

Just as subordination permitted AAA-rated securities to be created from lower-rated loans in a non-agency RMBS, subordination also permitted additional AAA-rated securities to be created from the AA-rated, A-rated, and lower-rated tranches of RMBS. Because there are vastly more institutional purchasers of AAA-rated instruments than of lower-grade securities (and particularly those that are below investment grade), the demand for AAA-rated CDOs facilitated the issuance of more non-agency RMBS and thereby also the origination of more subprime and Alt-A mortgage loans.

[13] *Inside Mortgage Finance*, cited in the testimony of Sandra L. Thompson, Director Division of Supervision and Consumer Protection, Federal Deposit Insurance Corporation, on Mortgage Market Turmoil: Causes and Consequences, before the Committee on Banking, Housing, and Urban Affairs, US Senate, Room 538, Dirksen Senate Office Building (March 22, 2007), 6.

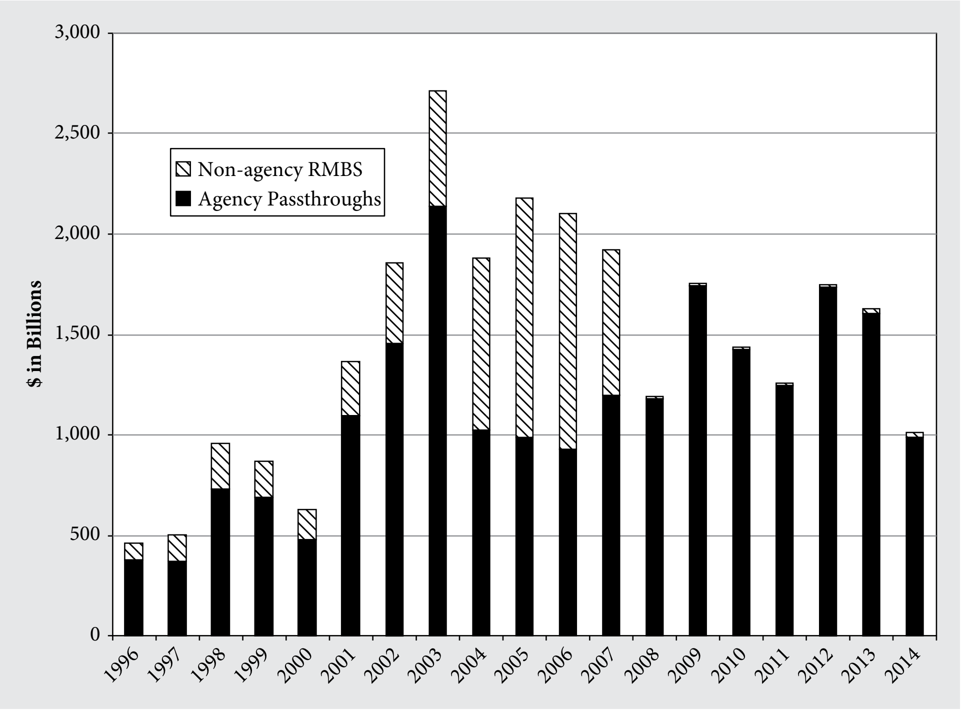

FIGURE 5.2 Issuance of new agency passthroughs and non-agency RMBS

Source: Chart constructed from data on agency MBS and non-agency RMBS, home equity, and manufactured housing, published in SIFMA, US Mortgage-Related Securities Issuance, sf-us-mortgage-related-sifma.xls. Bloomberg, Dealogic, Thomson Reuters, U.S. Agencies, SIFMA. Used with permission.

Aided by robust conditions in the housing market through mid-2005 (marked by a relatively strong overall economy and rising housing prices), mortgage performance, as measured by delinquencies and foreclosures, improved from 2002 through 2005. The percentage of subprime loan delinquencies reached a low in the second quarter of 2005 of just over 10%, down from 15% in 2002. The foreclosure rate for subprime loans fell from just under 9% to just over 3% in the same period. Delinquency and foreclosure rates for prime loans behaved in a similar way, although starting out at much lower levels of 2.5% to 0.5%, respectively.

Investors in Non-Agency RMBS

Investors in non-agency RMBS in the years leading up to the subprime crisis included depository institutions, pension funds, mutual funds, insurance companies, hedge funds, and investment banks. The GSEs were also large investors in this market, notwithstanding their role in the agency market. See Table 5.1.

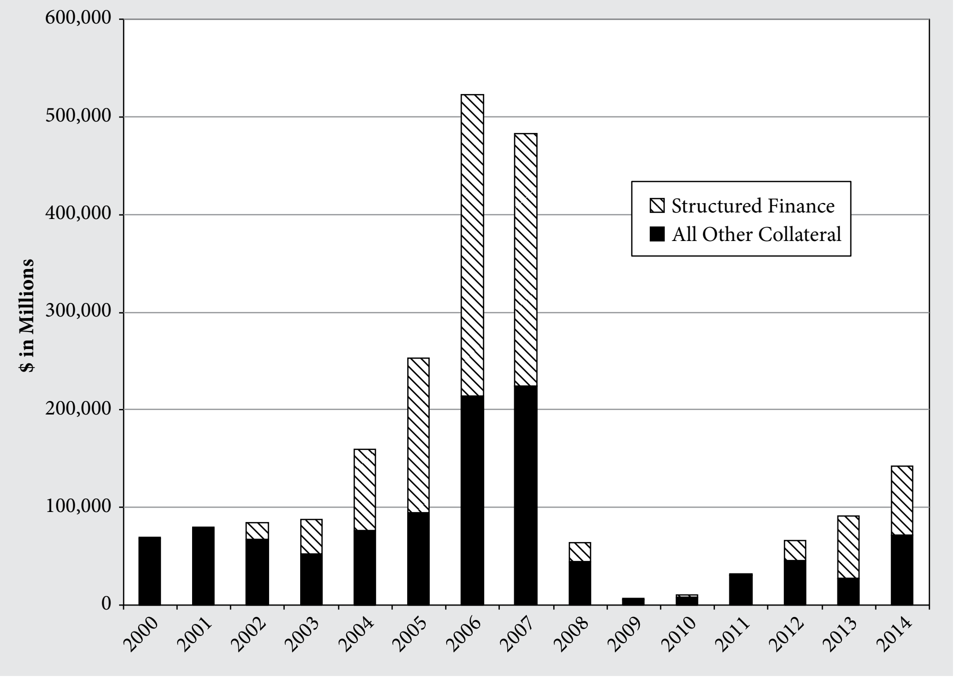

FIGURE 5.3 Issuance of collateralized debt obligations by type of collateral

Source: Chart constructed from data on structured finance and total CDO issuance, published in SIFMA, Global CDO Issuance, sf-global-cdo-sifma.xls. Thomas Reuters, SIFMA. Used with permission.

Table 5.1 Holders of mortgage securities, billions of dollars, 2008

Holder of Mortgage Debt	Agency MBS	Non-agency AAA	CDO Subord.	Non-CDO Subord.	Total	Percentage of Total
Banks and Thrifts	$852	$383	$90	$	$1,325	20%
GSEs and FHLB	741	308			1,049	16
Broker-Dealers	49	100	130	24	303	5
Financial Guarantors			100		100	2
Insurance Companies	856	125	65	24	1,070	16
Overseas	689	413	45	24	1,171	18
Other	1,175	307	46	49	1,577	24
Total	4,362	1,636	476	121	6,595	
Percentage of Total	66%	25%	7%	2%		

Source: Lehman Brothers, Arvind Krishnamurthy, "The Financial Meltdown: Data and Diagnoses," Northwestern University Working Paper (2008), as presented in Dwight Jaffee, Anthony Lynch, Matthew Richardson, and Stijn Van Nieuwerburgh's "Mortgage Origination and Securitization in the Financial Crisis," in Viral Acharya and Matthew Richardson (eds), *Restoring Financial Stability: How to Repair a Failed System* (Hoboken, NJ: John Wiley & Sons, 2009), 72.

From 2003 to 2007, Fannie Mae and Freddie Mac expanded their participation in the market for subprime and Alt-A loans. They bought these loans to hold in their portfolios, or to securitize (thereby applying their agency guarantees to nonconforming loans). The share of high LTV (above 80%) loans acquired or securitized grew by more than half (from 15% to 25% at Fannie Mae; from 12% to 19% at Freddie Mac). The share of loans with second liens doubled over the period.[14] Concurrently, the share of borrowers with credit scores below 660 (a common definition of subprime) increased slightly (from 14% to 18% of new loan purchases and securitizations at Fannie Mae; from 12% to 19% at Freddie Mac).[15] The two GSEs also purchased non-agency RMBS to hold in their portfolios. By 2006, Fannie Mae held $80.3 billion in non-agency RMBS and Freddie Mac held $157.5 billion.[16]

In 2006, following the 2004 disclosure of accounting issues at Fannie Mae and Freddie Mac, their federal regulator imposed limits on the GSEs' ability to purchase mortgages and mortgage-backed securities. Although no restriction was placed on guarantees of securities purchased by others, the episode did reduce the GSEs' ability to support the non-agency RMBS market.

The Collapse of the Non-Agency RMBS Market

The US experienced appreciation in housing prices for more than 20 years. At the national level, housing prices roughly doubled from the end of 1987 to the middle of 2002.[17] As shown in Figure 5.4, from 2000 to 2006, the rate of increase accelerated. Depending on which index is used, national housing prices increased 60%–80% from 2000 to 2006. Prices of housing in urban areas showed even greater increases. An index of housing prices in the top ten metropolitan areas (i.e., the S&P/Case-Shiller MSA Composite-10 Index) increased by over 125% from 2000 to the peak in 2006.

[14] Ronel Elul, "The Government-Sponsored Enterprises: Past and Future," *Business Review,* Federal Reserve Bank of Philadelphia (Q1 2015), 15.

[15] Frame, Fuster, Tracy, and Vickery, "The Rescue of Fannie Mae and Freddie Mac," 45–6.

[16] Theresa R. DiVenti, Office of Policy Development and Research, US Department of Housing and Urban Development, "Fannie Mae and Freddie Mac: Past, Present, and Future," *Cityscape: A Journal of Policy Development and Research* 11/3 (2009), 237.

[17] From 1Q 1987 through 2Q 2002 the Office of Federal Housing and Enterprise Oversight ("OFHEO") House Price Index increased 88%, while the S&P/Case-Shiller US National Home Price Index increased 97%. The OFHEO House Price Index is based on repeat sales of single-family properties involving conforming, conventional mortgages purchased or securitized by Fannie Mae or Freddie Mac. The S&P/Case-Shiller US National Home Price Index aggregates nine quarterly US Census division repeat sales indices.

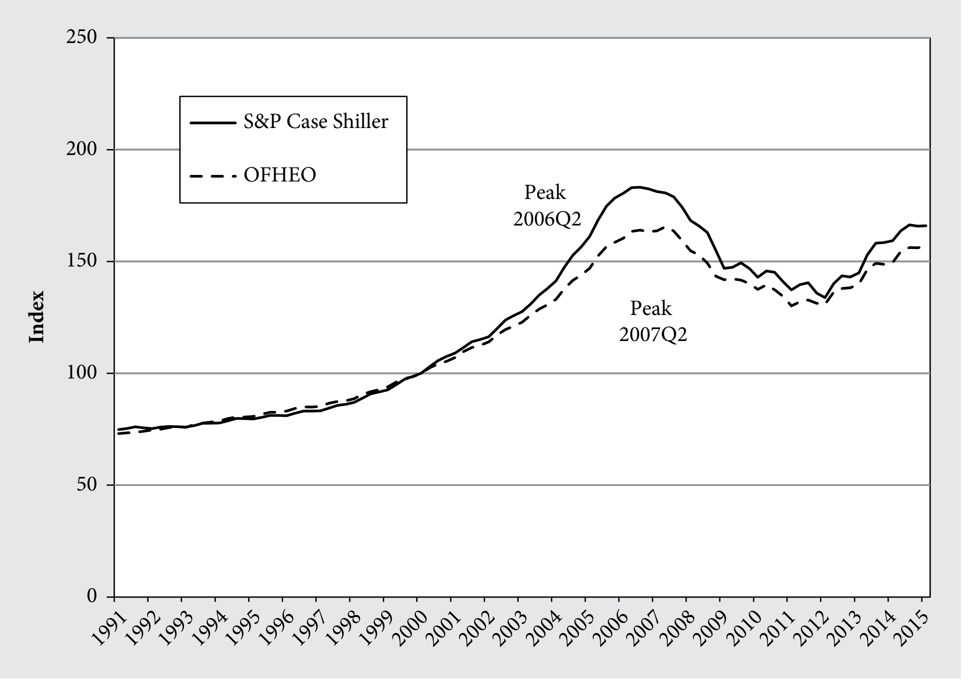

FIGURE 5.4 Quarterly national housing price indices, 1987–2007

Note: Data are quarterly and are indexed to 100 in 1Q 2000

Source: Data obtained from the Office of Federal Housing Enterprise Oversight and Standard & Poor's. S&P Dow Jones Indices and CoreLogic. Used with permission. S&P/Case-Shiller U.S. National Home Price Index is proprietary to and is calculated, distributed and marketed by S&P Opco, LLC (a subsidiary of S&P Dow Jones Indices LLC), its affiliates and/or its licensors and has been licensed for use. S&P® is a registered trademark of Standard & Poor's Financial Services LLC; Dow Jones®, is a registered trademark of Dow Jones Trademark Holdings LLC and Case-Shiller® is a registered trademark of CoreLogic Case-Shiller, LLC. © 2015 S&P Dow Jones Indices LLC, its affiliates and/or its licensors. All rights reserved.

The decline of housing prices, starting between mid-2006 and early 2007 and continuing until 2012, reflected the underlying economics of the housing sector. Starting in 2005, existing home sales and housing starts declined and existing home inventories increased starting in 2005.[18] Housing price appreciation turned sluggish in 2005 and, by early to mid-2006, housing prices started declining in many areas. The S&P/Case-Shiller National Index declined over 10% from its peak in 2006 through the end of 2007.[19] In many urban areas, housing price declines were steeper. The US housing boom had come to an end, with housing demand weakening and the sales of both new and existing homes falling significantly by mid-2006. This weakening in the housing sector translated into decreased originations for mortgage lenders.

[18] See Federal Reserve Chairman Ben S. Bernanke, "The Economic Outlook," Testimony before the Joint Economic Committee, US Congress, March 28, 2007. See also data from the National Association of Realtors and the Department of Commerce.

[19] The index peaked at 189.93 in the second quarter of 2006. By the end of 2007, the index had fallen to 170.61.

Rising Mortgage Defaults and Delinquencies

The end of the US housing boom led to increases in seriously delinquent mortgage loans and foreclosures for both prime and subprime mortgages, beginning in 2006 and accelerating into 2007. Several economic and financial factors contributed to rising delinquency rates. Part of the deterioration of subprime loan performance can be attributed to regional macroeconomic factors.[20] Another important contributor was an increase in short-term interest rates (the Fed began raising the overnight lending rate in June 2004).[21]

Partly as a result of the deceleration of housing price appreciation that became evident in 2006, delinquency and foreclosure rates on subprime and prime mortgages began to rise. By the end of 2007, delinquency and foreclosure rates were reaching the peaks recorded in the previous cycle in 2002. The delinquency rate of subprime loans rose from 15% to just over 25% by the beginning of 2010, while the foreclosure rate rose from 9% to around 15%. See Figure 5.5.

Pricing and Performance of Agency and Non-Agency Securities

The housing bust and accumulating evidence of continuing poor mortgage performance led to a decline in the values of subprime mortgage-related assets in February 2007, followed by further sharp declines in June and July 2007.

The yield spreads of agency passthroughs and non-agency RMBS to their respective benchmarks remained generally stable from 2002 until July 2007 (see Figure 5.6). In July 2007, spreads widened for both agency and non-agency securities. However, the effects on non-agency RMBS (particularly subprime) were much more pronounced and longer lasting. While agency passthrough spreads recovered by mid-2009, subprime RMBS spreads, which had increased sharply to over 1,200 basis points, were still at extremely elevated levels in late 2010.[22]

[20] International Monetary Fund, "Global Financial Stability Report: Market Developments and Issues," IMF World Economic and Financial Surveys (April 2007), 4–7.

[21] Federal Reserve Bank of New York, <http://newyorkfed.org/markets/statistics/dlyrates/fedrate.html>, updated February 18, 2010.

[22] The non-agency universe was not composed solely of subprime MBS. Alt-A and Jumbo were prime non-agency categories that experienced similar spread widening over the 2007–10 period. Unlike subprime, however, these spreads did not blow out to the same degree and the dislocation was more short-lived.

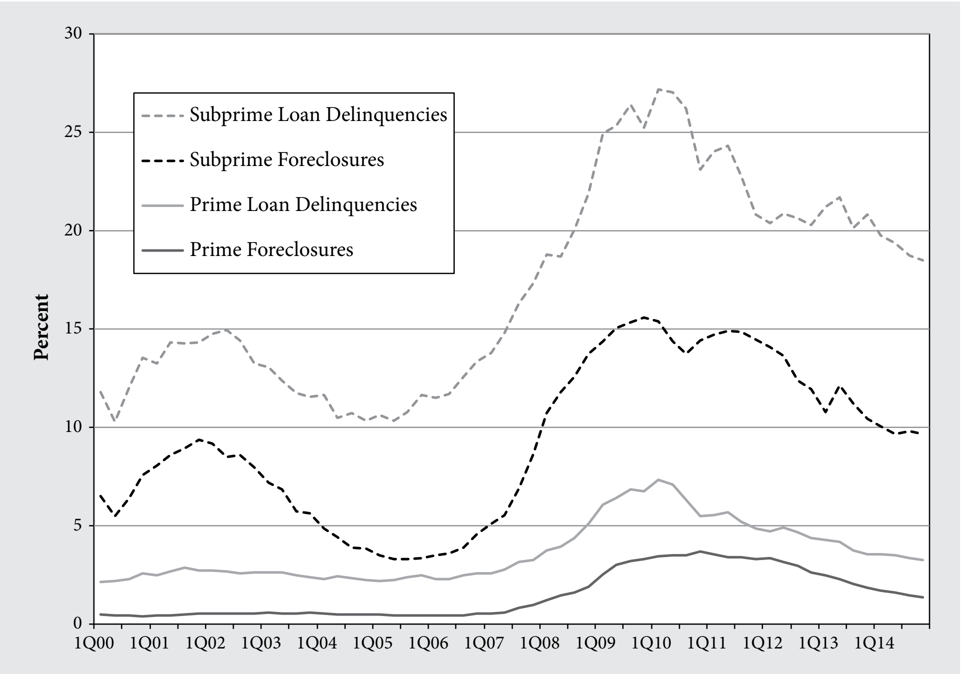

FIGURE 5.5 Delinquencies and foreclosures
Note: Data are seasonally adjusted

Source: Chart constructed from data published by Mortgage Bankers Association

The widening in spreads of course affected investment returns (see Figure 5.7). Total return indices for both agency passthroughs and non-agency RMBS grew steadily from 2002 until 2008. From 2008 until 2015, the total return index of agency passthroughs continued to grow at approximately the same rate.

AAA subprime RMBS, on the other hand, experienced a period of negative returns starting in mid-2007 and persisting until late 2009. While the cumulative total returns for the non-subprime products from 2002 to 2009 were approximately 50%, AAA subprime experienced a total return of about negative 15%.

Exit of Mortgage Originators

Non-agency RMBS issuance was supported by a number of financial institutions and companies specializing in mortgage origination. Table 5.2 lists the top 25 mortgage securities producers in 2006, and their share of agency passthrough and non-agency RMBS production.

As prices for non-agency RMBS declined, banks and financial institutions holding these mortgage-related assets were forced to attempt to deleverage by raising capital and severely curtailing lending. In early August 2007, the housing bust turned into an unexpected

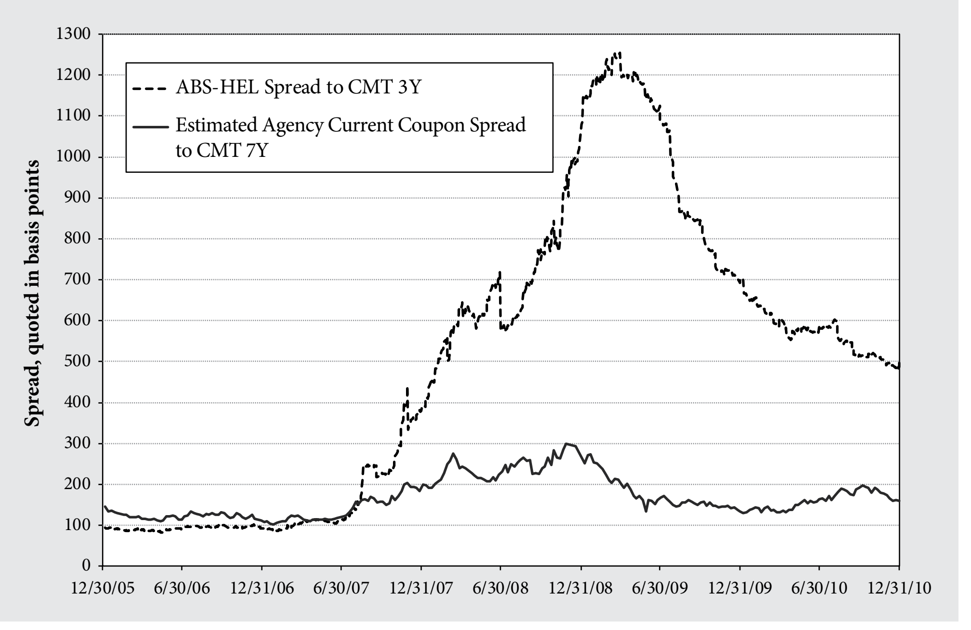

FIGURE 5.6 Spreads for agency passthroughs and non-agency RMBS, percent

Note: The agency current coupon is estimated by subtracting 50 bps from the prime conventional mortgage rate and converting to bond equivalent yield

Source: ABS spread to CMT 3Y data are from Bank of America, BofA Merrill Lynch Global Research, used with permission. Prime conventional mortgage rate data were retrieved from the Federal Reserve website.

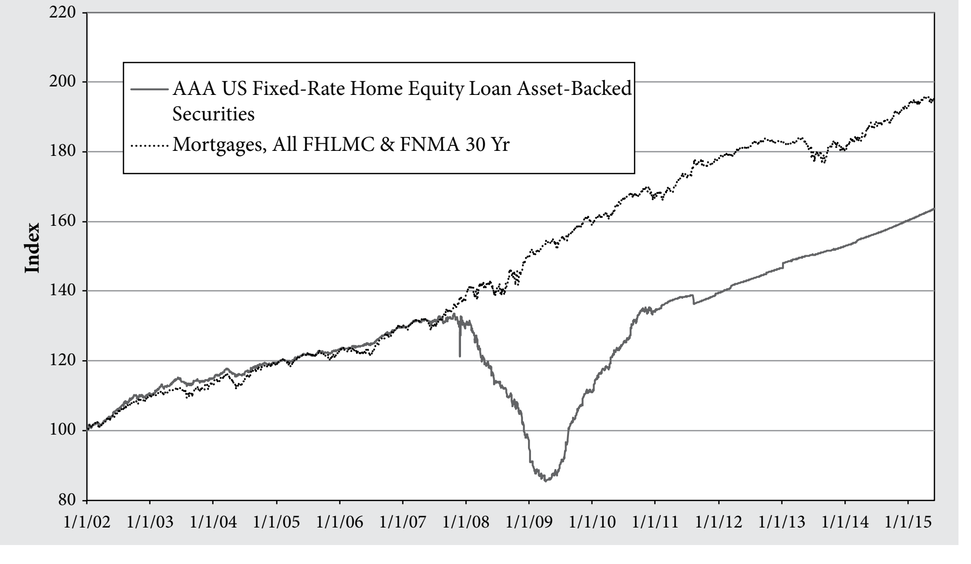

FIGURE 5.7 Total return indices for mortgage and non-mortgage indices

Note: Data end May 31, 2015. indices are pegged to 100 on January 1, 2002

Source: Data are from Bank of America. BofA Merrill Lynch Global Research, used with permission.

credit crisis as key segments of the credit market froze. Most importantly for originators of non-agency RMBS, the asset-backed commercial paper ("ABCP") market (a major source of funding) dried up. Demand for nonconforming mortgage loans also unexpectedly collapsed in the second half of 2007. Combined with the ABCP funding freeze, mortgage originators found it difficult to continue making nonconforming loans. By later 2007, the weakening housing market and increased mortgage delinquencies and foreclosures forced many subprime lenders to curtail lending or cease operating, as originations fell sharply.

Of the 25 largest securities producers in 2006, two lenders exited mortgage lending in their current form, three lenders closed, one stopped making loans, nine were sold, and four filed for bankruptcy.[23] Only issuers affiliated with large diversified banks continued to issue securities under the same corporate structure as in 2006. See Table 5.2. The following narrative summarizes the experience of one such firm, illustrating the challenges encountered in the non-agency RMBS market beginning in 2007.

The experience of New Century Financial Corporation exemplifies a number of the problems that affected subprime lenders. New Century was the second largest subprime originator in 2006, selling most of its loans to other firms, which then securitized them. On February 7, 2007, the company announced that it would restate its financial results for the first three quarters of 2006 to account for greater than expected losses from repurchasing loans that experienced early payment defaults or were in violation of representations and warranties. In the first nine months of 2006 investors sold $469 million of loans with early defaults back to New Century, about $220 million more than were repurchased in the same period the prior year. New Century was able to resell some of the loans, but at a discount. New Century and other mortgage originators were dependent on financing such as mortgage warehouse lines, to support mortgage production. New Century's lending agreements included covenants that required the company to be profitable and make filings on time. In early 2007, New Century violated those covenants and lenders were unwilling to waive the conditions. Unable to secure funding, New Century announced that it would stop accepting new loan applications. When New Century disclosed that it was in default on March 12, trading in the company's stock was suspended. On April 2, 2007, New Century filed for bankruptcy.[24]

[23] Similar liquidity problems caused the failures in 1998 of several firms involved in the origination and securitization of subprime mortgages. As in 2007–8, declines in the market value of subprime mortgages in 1998 led to margin calls and the withdrawal of funding. In 1998, however, the cause of the price declines was an unexpected increase in prepayment rates (not credit concerns), leading to writedowns on capitalized interest and consequent violations of lenders' covenants.

[24] Adam B. Ashcraft and Til Schuermann, "Understanding the Securitization of Subprime Mortgage Credit," Staff Report No. 318, Federal Reserve Bank of New York (March 2008), 4 (citing data from Inside Mortgage Finance); New Century Financial Corp., "New Century Financial Corporation to Restate Financial Statements for the Quarters Ended March 31, June 30 and September 30, 2006," Press Release attached to SEC Form 8-K (February 7, 2007); Julie Creswell and Vikas Bajaj, "Mortgage Crisis Spirals, and Casualties Mount," *New York Times*, March 5, 2007; New Century Financial Corp., SEC Form 8-K (March 2, 2007).

Table 5.2 Top mortgage security producers in 2006, dollars in millions

		Total MBS						
Rank	Issuer	Volume	Market Share	Non-agency	FNMA	FHLMC	GNMA	Current Status of Firm
1	Countrywide Financial	$342,877	16.7 %	$153,824.3	$123,913.8	$53,147.6	$11,991.5	Sold
2	Wells Fargo	196,740	9.6	60,401.4	21,816.4	90,752.3	23,770.3	Stopped loans
3	Washington Mutual	118,916	5.8	72,842.7	11,241.0	32,264.9	2,567.3	Sold
4	Lehman Brothers	86,774	4.2	69,413.3	10,374.4	6,986.7		Bankrupt
5	Chase Home Finance/ JPMorgan Chase	85,553	4.2	33,061.2	24,294.4	23,461.6	4,736.2	Remains in Business
6	Citigroup/ CitiMortgage	71,783	3.5	19,999.5	38,648.4	5,790.7	7,344.2	Remains in Business
7	Bear Stearns/ EMC Mortgage	68,097	3.3	64,229.1	1,467.3	2,400.9		Sold
8	Residential Funding Corp.	66,249	3.2	66,238.3		11.1		Bankrupt
9	IndyMac	51,348	2.5	40,158.0	8,958.8	2,231.5		Sold
10	Bank of America	51,099	2.5	24,606.5	18,665.3	7,168.7	658.5	Remains in Business
11	GMAC Mortgage	51,011	2.5	7,112.9	27,462.7	12,866.3	3,569.3	Bankrupt
12	Goldman Sachs	47,537	2.3	46,077.7	538.3	920.8		Remains in Business
13	New Century	35,471	1.7	35,318.5	152.8			Bankrupt/ Sold
14	Morgan Stanley	35,089	1.7	29,775.5	3,293.8	2,019.2		Remains in Business
15	Option One	31,260	1.5	31,260.1				Sold
16	SunTrust Mortgage	30,820	1.5	679.1	24,119.0	4,291.6	1,730.6	Remains in Business
17	Credit Suisse/DLJ Mortgage Capital	30,197	1.5	28,770.3	437.8	988.4		Remains in Business

18	Fremont	29,859	1.5	29,793.7	19.8	45.9		Closed Unit/Sold
19	First Franklin	28,257	1.4	28,257.0				Sold
20	RBS Greenwich Capital	28,001	1.4	28,001.1				Exited U.S. Business
21	Deutsche Bank	25,328	1.2	25,328.2				Remains in Business
22	WMC Mortgage	21,620	1.1	21,620.1				Closed Unit/Sold
23	Ameriquest Mortgage	21,652	1.1	21,609.9		42.0		Closed Unit
24	First Horizon Mortgage	21,459	1.0	9,427.7	8,771.8	1,879.3	1,379.9	Closed Subprime Unit[a]
25	ABN AMRO Mortgage Group	21,341	1.0		1,693.0	19,512.2	136.0	Sold
	Top 10 Issuers	$1,139,438	55.6 %	$604,774	$259,380	$224,216	$51,068	
	Top 50 Issuers	1,867,450	91.1	1,085,163	393,336	318,488	70,463	
	Total Market	2,050,159		1,145,612	456,857	364,635	83,055	

Note: [a] Non-Tennessee loan operations were sold to Metlife.
Source: Securities production data are from Inside Mortgage Finance MBS Database. Used with permission.

To understand the shift in mortgage securities holdings away from non-agency RMBS, it is helpful to look at annual issuance figures net of repayments (and, in the case of non-agency RMBS, net of writedowns). Many new mortgages are originated as replacements for existing loans that are paid off, either through refinancing or a homeowner's trading homes. It is notable that repayments and writedowns have vastly exceeded new issuance for non-agency RMBS since 2008. The GSEs replaced a substantial portion of the decline in non-agency activity for 2007–9, but their net issuance activity has since fallen below their pre-crisis levels. See Figure 5.8.

Ratings Downgrades of Non-Agency RMBS

In the summer of 2007, the credit rating agencies began downgrading previously issued non-agency RMBS. See Figure 5.9. The rating agencies also announced that they were revising their ratings criteria for securities backed by Alt-A and subprime loans.[25]

[25] See, for example, Moody's reports "US Alt-A RMBS—Moody's Updates its Methodology: August 2007" (August 21, 2007); "US Subprime—Overview of Recent Refinements to Moody's Methodology: July 2007"

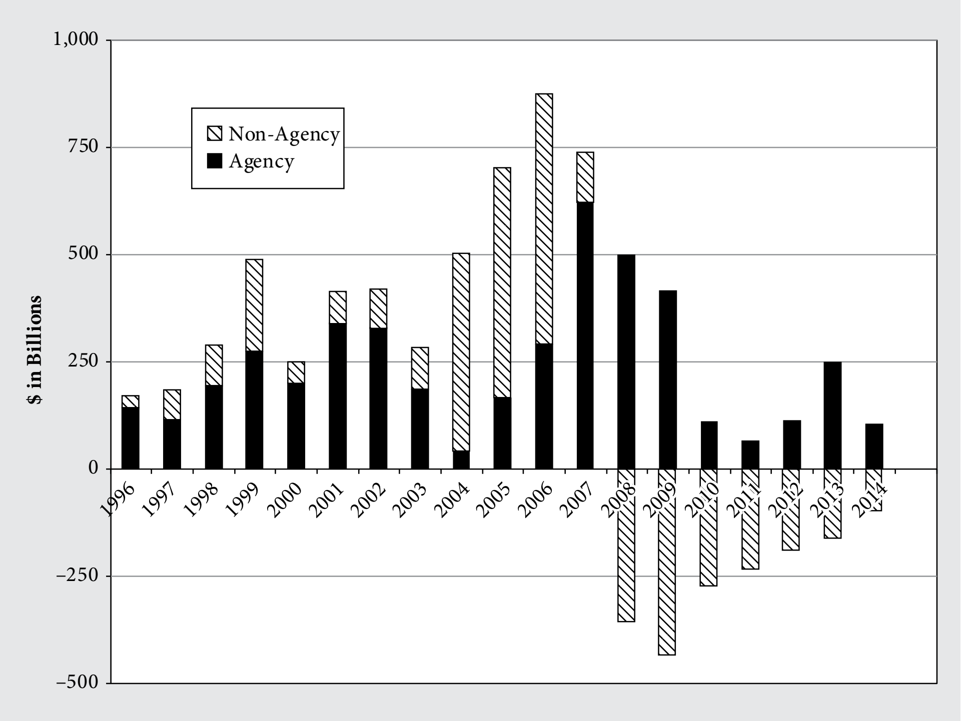

FIGURE 5.8 Net US residential mortgage security issuance

Source: Chart constructed from data on agency and non-agency RMBS, published in SIFMA, US Mortgage-Related Securities Outstanding, sf-us-mortgage-related-sifma.xls. Used with permission.

As of mid-2009, almost 70% of the non-agency RMBS originally rated AAA had been downgraded below investment grade.[26] The average downgrade for securities backed by Alt-A mortgages was more than ten notches for securities issued in the first quarter of 2007, and seven notches for securities backed by subprime mortgages.[27]

The CDO market was even more adversely affected, as would be expected from the structural leverage inherent in that type of security. The average downgrade for CDO

(August 2, 2007); "Update to Moody's Approach to Analyzing Delinquent Loans Included in Performing Subprime US RMBS" (August 21, 2007); "Rating US Option ARM RMBS—Moody's Updated Rating Approach" (September 4, 2007). Standard & Poor's reports on methodology changes include "U.S. RMBS Closed-End Second-Lien Cash Flow Methodology Revised" (May 4, 2007); "Standard & Poor's Revised Default and Loss Curves for U.S. Subprime RMBS" (October 19, 2007); "Standard & Poor's Revised Default and Loss Curves for U.S. Alt-A RMBS Transactions" (December 19, 2007). Fitch issued "U.S. RMBS Cash Flow Modeling Criteria for Second-Lien Mortgage Products: Updated" (February 6, 2007); "Downgrade Criteria for Recent Vintage U.S. Subprime RMBS" (August 8, 2007); "Global Criteria for the Review of Structured Finance CDOs with Exposure to US Subprime RMBS" (November 15, 2007).

[26] National Association of Insurance Commissioners and the Center for Insurance Policy and Research, "Structured Securities Project" (May 14, 2015), available at <http://www.naic.org/cipr_topics/topic_structured_securities.htm>.

[27] Adam Ashcraft, Paul Goldsmith-Pinkham, and James Vickery, "MBS Ratings and the Mortgage Credit Boom," Staff Report No. 449, Federal Reserve Bank of New York (May 2010), figure 1.

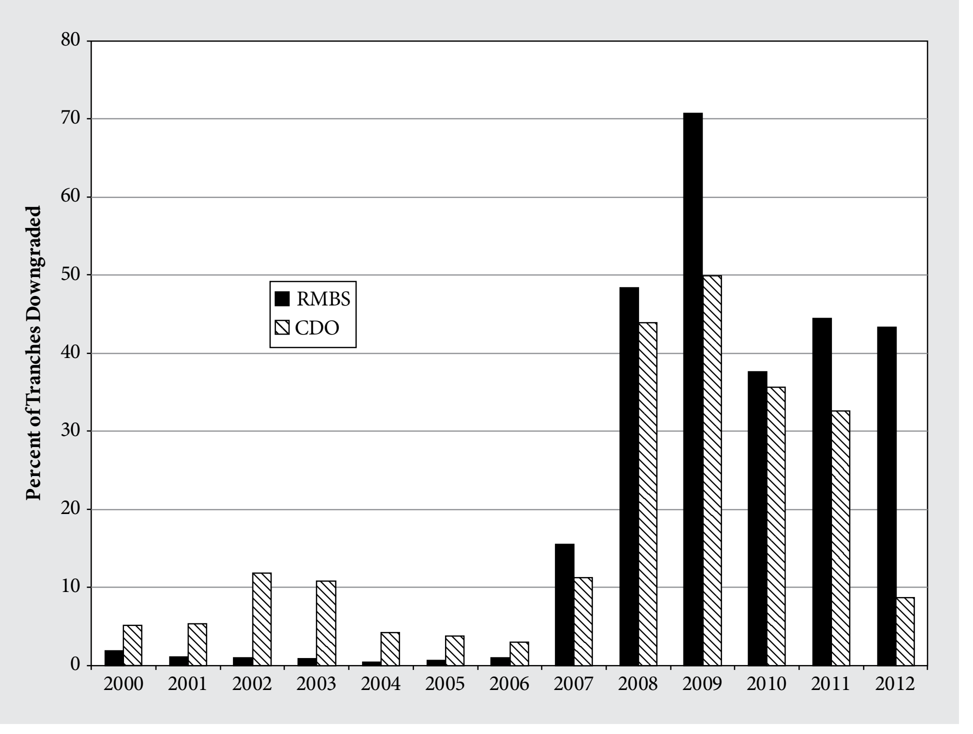

FIGURE 5.9 RMBS and CDO downgrades

Source: Chart constructed from data published by Standard & Poor's, "Global Structured Finance Default Study, 1978–2012: A Defining Moment for Credit Performance Stability" (March 30, 2013). Reproduced with permission of Standard & Poor's Financial Services LLC. Standard & Poor's Financial Services LLC (S&P) does not guarantee the accuracy, completeness, timeliness or availability of any information, including ratings, and is not responsible for any errors or omissions (negligent or otherwise), regardless of the cause, or for the results obtained from the use of ratings. S&P GIVES NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICUALR PURPOSE OR USE. S&P SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, EXEMPLARY, COMPENSATORY, PUNITIVE, SPECIAL OR CONSEQUENTIAL DAMAGES, COSTS, EXPENSES, LEGAL FEES or LOSSES (INCLUDING LOST INCOME OR PROFITS AND OPPORTUNITY COSTS) IN CONNECTION WITH ANY USE OF RATINGS. S&P's ratings are statements of opinions and are not statements of fact or recommendations to purchase, hold or sell securities. They do not address the market value of securities or the sustainability of securities for investment purposes, and should not be relied on as investment advice.

tranches originally rated AAA was 15 notches (B minus) for the 2006 vintage and 17 notches (CCC) for the 2007 vintage.[28]

Factors that Affected the Mortgage Securities Market

Several key factors contributed to the severity of the crisis in the subprime mortgage industry. House price appreciation was one of the primary factors originators and investors in riskier mortgages relied on to support their assumptions regarding expected

[28] Moody's Investment Services, "Structured Finance CDO Rating Surveillance Brief—Third Quarter 2008" (October 24, 2008).

cash flows. In the years just before the subprime crisis, banks and other originators adopted looser underwriting standards that explicitly allowed for riskier mortgages and combinations of factors that also increased risk in potentially unforeseen ways. Lastly, many subprime originators and non-agency RMBS issuers relied on short-term leverage in the form of external financing for funds to make and process mortgages prior to selling them in securitizations.

Non-agency RMBS were held in investment vehicles or by entities that relied on leverage as well. Prior to the subprime crisis, there was ample liquidity for this funding. When market conditions began to deteriorate, however, mortgage originators found that their creditors were unwilling to continue to extend credit, and their dependence on credit contributed to their exits. For RMBS investors, declines in RMBS prices and principal losses reduced equity and caused numerous investors to deleverage. Asset sales put further downward pressure on market prices and contributed to additional writedowns and asset dispositions.

Reliance on Uncorrelated Regional House Prices and Growth in House Prices

Generally increasing housing prices on a national level from the 1970s through 2005 contributed to the growth of the non-agency RMBS market and the subsequent decline in housing prices on the national level contributed to the crisis. The historical record of the experience with declining prices and defaults and foreclosures on regional levels shows that prior to 2000, regional housing markets were largely uncorrelated; while after 2000, housing markets were positively correlated.[29]

National nominal house price indices had rarely, if ever, fallen between 1975 and 2005. While real housing prices fell in four periods, nominal housing prices are important for this market because debt is carried in nominal terms. On a regional basis, however, there had been significant periods of nominal price decline. For example, between 1975 and 2000 California experienced two episodes of rapid price increases with a drop in-between, the Northeast experienced a boom and a bust, and Texas and the West South Central region experienced a housing bust. However, the bust in Texas and West South Central region house prices that occurred during the mid to late 1980s roughly coincided with house price booms in California (1984–90) and the Northeast (1984–8). The boom in California house prices lasted longer than the boom in the Northeast, and overlapped the period when prices fell in the Northeast (1988–92). In general, prior to 2000 house prices were not correlated across regions and the housing busts were generally associated with a downturn in the regional economy.[30]

The valuations of non-agency RMBS, given the levels of subordination required for particular credit ratings, rested in part on the assumption that housing prices would continue

[29] See Karl Case, "The Central Role of House Prices in the Financial Crisis: How Will the Market Clear?" *Brookings Papers on Economic Activity* (Fall 2008).

[30] Case, "The Central Role of House Prices in the Financial Crisis: How Will the Market Clear?"

to appreciate or, if there were declines, that they would be uncorrelated across regions. More leveraged underlying loans were more likely to result in negative equity if house prices fell, and homeowners with negative equity were more likely to default. Other loans with low initial rates relied on homeowners using price appreciation periodically to refinance into new mortgages to keep the payments affordable. These instruments were at greater risk for default when house price appreciation slowed and prices began to decline in 2006 and 2007.

Insufficiently Robust Underwriting Standards

Many factors ultimately contributed to the high levels of losses on securities backed by subprime and Alt-A loans. The boom in mortgage financing was motivated in part by a loosening of underwriting standards. In 2006 and 2007, lenders explicitly and openly lowered their minimum standards for loan approval, accepting higher levels of subordination when those loans were securitized. But the amount of subordination, particularly in the presence of risk layering, came to be seen as inadequate for the relaxed underwriting criteria, especially during an economic downturn. There have also been widespread allegations of substantive deviations from the stated criteria, meaning that loans were actually riskier than disclosed.

The Survey of Credit Underwriting Practices produced by the Office of the Comptroller of the Currency documented the changes in underwriting practices. The Survey found that the market changed beginning in 2005, stating, "Notably, this is the first time in the survey's 11-year history that examiners reported net easing of retail underwriting standards."[31] A similar finding was reported in the 2006 and 2007 Surveys.[32] These changes are reflected in measures of loan quality as well. For example, between 2001 and 2006 the average combined loan to value of subprime loans increased from 79.8% to 89.1%; the share of subprime loans with limited documentation increased from 27% to 44%, and the fraction of loans that had both limited documentation and so-called piggyback loans increased from 1% to 15%.[33]

[31] Office of the Comptroller of the Currency (OCC), "Survey of Credit Underwriting Practices" (June 2005), 5.

[32] "For the second consecutive year, examiners noted easing of retail credit standards in more than a quarter of the banks surveyed. . . . Easing standards for home equity lending, both conventional and high loan-to-value, include longer interest-only periods, the offering of 'piggy back' loans to avoid mortgage insurance requirements, lower scorecard cutoffs, and higher allowable debt-to-income and loan-to-value ratios." OCC, Survey of Credit Underwriting Practices (October 2006), 6; OCC, Survey of Credit Underwriting Practices (October 2007), 5–7.

[33] Viral Acharya, Thomas Philippon, Matthew Richardson, and Nouriel Roubini, "A Bird's Eye View—The Financial Crisis of 2007–2009: Causes and Remedies," 10, figure citing LoanPerformance and Paulson & Co.; Viral Acharya and Matthew Richardson (eds), *Restoring Financial Stability: How to Repair a Failed System* (New York: New York University Stern School of Business, 2009), 20.

The rise in mortgage defaults, delinquencies, and foreclosures is associated with falling house prices as well as increasingly risky borrowers and declining underwriting standards. Research conducted by Federal Reserve economists finds that, while the incidence of subprime defaults is related to the riskiness of borrower pools and underwriting standards, the rate of housing price increases or decreases explains more of the changes in mortgage default rates.[34]

Illiquidity in Credit Markets

In the spring and summer of 2007 in response to actual and anticipated losses on assets and changes in financial markets, individual financial firms struggled to increase capital and deleverage. Financial firms sold assets to deleverage their balance sheets. The unanticipated systemic impact of so many firms attempting to deleverage simultaneously depressed asset prices, producing additional losses. Depressed prices resulted in further losses, additional selling, and greater writedowns. In some firms, equity cushions declined even further, thereby increasing instead of lowering leverage.[35]

Individual actions designed to reduce risk resulted in widely unanticipated and negative systemic consequences. A vicious cycle led to outright illiquidity in markets for some asset-backed securities, making it extremely difficult to determine fair values and eliminating the ability to use them as collateral for additional lending or for new securitizations. As the credit markets froze, financial institutions became reluctant to lend to one another, even at short maturities. Firms began hoarding liquidity, uncertain about what liquidity demands they might face and whether or not they could be met.

[34] Kristopher S. Gerardi, Andreas Lehnert, Shane M. Sherland, and Paul S. Willen, "Making Sense of the Subprime Crisis," Working Paper No. 2009–2, Federal Reserve Bank of Atlanta (February 2009); Kristopher Gerardi, Adam Shapiro, and Paul Willen, "Subprime Outcomes: Risky Mortgages, Homeownership Experiences, and Foreclosures," Working Paper No. 07–15, Federal Reserve Bank of Boston (May 2008); Christopher Foote, Kristopher Gerardi, Lorenz Goette, and Paul Willen, "Subprime Facts: (What We Think) We Know about the Subprime Crisis and What We Don't," Public Policy Discussion Papers No. 08–2, Federal Reserve Bank of Boston (May 2008).

[35] See Olivier Blanchard, "The Crisis: Basic Mechanisms, and Appropriate Policies," IMF Working Paper WP/09/80 (April 2009); Markus Brunnermeier, "Deciphering the Liquidity and Credit Crunch 2007–2008," *Journal of Economic Perspectives* 23/1 (Winter 2009), 77–100; David Greenlaw, Jan Hatzius, Anil K. Kashyap, and Hyun Song Shin, *Leveraged Losses: Lessons from the Mortgage Market Meltdown: Proceedings of the U.S. Monetary Policy Forum 2008* (Rosenberg Institute, Brandeis International Business School and Initiative on Global Markets, University of Chicago Graduate School of Business, 2008).

Federal Government Response to the Crisis

During the credit crisis many entities withdrew or reduced the liquidity they provided for many forms of borrowing, including mortgage lending.[36] As described, subprime originations were substantially reduced and issuance of non-agency RMBS fell to levels not seen for about 20 years. In response to the financial crisis, the federal government put in place many programs to extend new mortgage credit or modify existing loans.

Mortgage Assistance Programs

Several new programs were established to assist mortgagors in replacing or modifying their current loans to make monthly payments more manageable and/or loan balances more in line with current property values. Mortgage loan modifications involve changing (modifying) the terms of a mortgage in order to lessen monthly payments due to financial hardship on behalf of the borrower.[37] Some of these programs are as follows:

- Home Affordable Modification Program (HAMP)—modification of existing conforming loans owned by Fannie Mae or Freddie Mac that are current on their payments by reducing interest rate and/or extended term to lower monthly payments.
- FHA Home Affordable Modification Program (FHA-HAMP)—a program for FHA-insured loans similar to HAMP.
- Veteran's Affairs Home Affordable Modification (VA-HAMP)—a program for VA-guaranteed loans similar to HAMP.
- Principal Reduction Alternative (PRA)—a program to encourage mortgage servicers and investors to reduce principal balances on underwater mortgages.
- Second Lien Modification Program (2MP)—a supplement to HAMP for borrowers with second mortgages.
- Second Lien Modification Program for Federal Housing Administration Loans (FHA-2LP)—a supplement to FHA-HAMP for borrowers with second mortgages.

[36] See Tobias Adrian, Brian Begalle, Adam Copeland, and Antoine Martin, "Repo and Securities Lending," Staff Report No. 529, Federal Reserve Bank of New York (December 2011; revised February 2013), 8–11.

[37] The reduction of monthly payments is relative to the monthly payments but for modification. While uncommon, it is possible that the modification can cause increased monthly payments over the term of the loan (e.g., for adjustable-rate mortgages).

- USDA's Special Loan Servicing—a program to lower monthly payments for rural mortgages guaranteed under the Section 502 program of the US Department of Agriculture.
- Home Affordable Foreclosure Alternatives Program (HAFA)—an arranged sale of the home and cancellation of any remaining mortgage debt not payable from the sale proceeds.
- Home Affordable Refinance Program (HARP)—refinancing of existing conforming loans owned by Fannie Mae or Freddie Mac that are current on their payments to lower monthly payments.
- FHA Refinance for Borrowers with Negative Equity (FHA Short Refinance)—refinancing of existing underwater FHA-insured loans that are current on their payments to reduce the principal balance to no more than 97.75% of property value.
- Home Affordable Unemployment Program (UP)—a program to reduce or suspend monthly mortgage payments for unemployed homeowners.
- Hardest Hit Fund (HHF)—an alternative for homeowners ineligible for HAMP in the states most affected by the credit crisis.

New mortgage originations under the HAMP program totaled 638,000 loans through December 31, 2014. Originations under all other programs totaled 960,000 loans through the same date.[38]

Changes in FHA Fees

When subprime lenders began withdrawing from the market in 2007, many borrowers turned to the FHA. Originations of FHA-insured loans on single-family homes averaged about $55 billion in each of 2005 and 2006, with a market share of barely 2%. Originations increased to $77 billion in 2007 and then jumped to $357 billion in 2008. The FHA's market share exceeded 15% in 2008–10.[39] By number of loans, the FHA's market share was 21%, or 33% when considering only loans for home purchase (not refinancing).[40] Virtually all of these FHA originations were immediately securitized in Ginnie Mae passthroughs.

As the private mortgage market recovered, the federal government's interest shifted toward ensuring that the FHA program would be fiscally sound. In 2012, the upfront insurance premium was raised by 0.75 percentage points and the annual premium was raised by 0.10 to 0.35 percentage points. In 2013, the FHA extended the term during

[38] Federal Housing Finance Agency, "Foreclosure Prevention Report" (4Q 2014), 4.

[39] US Department of Housing and Urban Development, "FHA Single-Family Market Share," (4Q 2014), 2.

[40] Harriet Newberger, "FHA Lending: Recent Trends and their Implications for the Future," Federal Reserve Bank of Philadelphia (December 2011), 1.

which the annual premium was assessed. The FHA's market share of single-family mortgage originations has hovered in the range of 11% to 12% since 2012.[41]

Amid concerns over a faltering economic recovery, the FHA rolled back some of the annual premium increases for loans originated after mid-January 2015.

Expansion of the Role of the GSEs

Although overall mortgage securities issuance fell after 2007, the credit crisis had a differential impact across types of securities. Non-agency RMBS annual issuance began a rapid decline post-2007 as it was affected by the credit crisis and the recession that began at the end of 2007. In contrast, agency passthrough issuance was relatively unaffected by the onset of the crisis, as slower originations in the GSEs' traditional markets were offset by initiatives to support borrowers previously served by the non-agency sector. As a result, agency passthrough issuance increased in 2009 by more than 33% above 2008 levels. In the years just after 2008, non-agency RMBS annual issuance remained at low levels not seen since the early 1990s, while agency passthrough annual issuance remained higher than it was in 2006–8.

Because nearly all FHA (and VA) single-family originations are securitized in Ginnie Mae pools, the surge in FHA originations beginning in 2008 was reflected in higher Ginnie Mae securitizations: from $82.3 billion in 2006 and $95.5 billion in 2007, Ginnie Mae securitization jumped to $269.0 billion in 2008 and $446.2 billion in 2009.[42] Loan limits on Fannie Mae and Freddie Mac were relaxed, allowing those firms to provide additional housing finance as the non-agency RMBS market withered. See Figure 5.10.

After the housing crisis, the number of modified (and delinquent) loans increased. As such, the GSEs have amassed a material amount of these loans in their portfolios. Since September 2008, 1.8 million permanent loan modifications were made through Fannie Mae and Freddie Mac.[43]

In May 2013, Freddie Mac started securitizing some of the performing modified mortgage loans held in the company's mortgage-related investments portfolio.[44] Two of Freddie Mac's securitization programs for modified loans are issued with "M" and "H" prefixes. The vast majority of M-pool loans were purchased by Freddie Mac out of its passthrough pools when the loans were at least 120 days delinquent. After at least six months of current payments, the loans were pooled into Freddie Mac's M program.[45]

41 US Department of Housing and Urban Development, "FHA Single-Family Market Share" (Q4 2014), 2.

42 Government National Mortgage Association, *2010 Annual Report*, figure 4.

43 Foreclosure Prevention Report, Federal Housing Finance Agency (4Q 2014), 4.

44 <http://freddiemac.mwnewsroom.com/press-releases/freddie-mac-securitizes-1-billion-of-performing-m-otcqb-fmcc-1020049>.

45 <http://freddiemac.mwnewsroom.com/press-releases/freddie-mac-securitizes-1-billion-of-performing-m-otcqb-fmcc-1020049>.

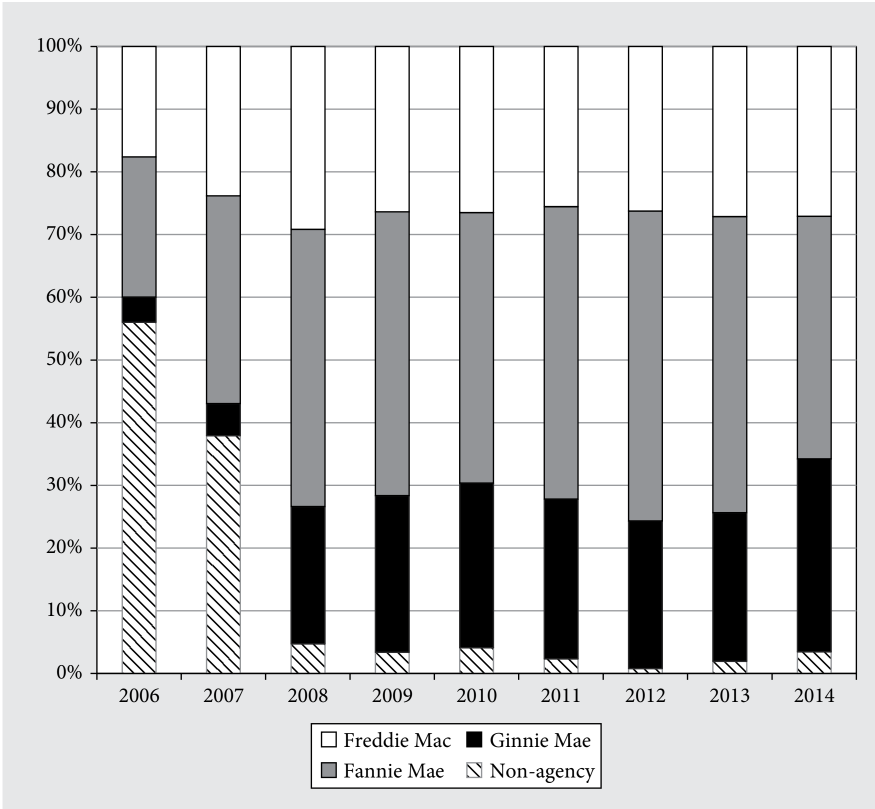

FIGURE 5.10 Mortgage-backed securities issuance market shares

Source: Ginnie Mae, Annual Reports, 2010 (p. 10) and 2014 (p. 26)

M-pool modifications predominately consist of term extensions; there are some rate reductions and some principal forbearances (not balance reductions). Freddie Mac's H pools include loans that were modified under the federal HAMP program, in which loans are modified through term extension and/or rate reduction. As of December 31, 2014, there were approximately $85.1 billion of modified loans in Freddie Mac's guarantee and investment portfolios.[46]

As of December 31, 2014, there were approximately $21.7 billion of modified loans in Fannie Mae's portfolio.[47] It had not securitized any modified loans.[48]

Ginnie Mae has allowed lenders to re-pool modified Federal House Administration (FHA) loans and Veterans Affairs (VA) loans since 1996 and 2000, respectively. Modified

[46] Freddie Mac, Form 10-K for 2014, dated February 19, 2015, p. 110.

[47] Fannie Mae, Form 10-K for 2014, dated February 20, 2015, p. 129.

[48] Fannie Mae Selling Guide, published May 26, 2015, accessible at <https://www.fanniemae.com/content/guide/selling/b2/1.4/02.html>.

loans are included with non-modified loans in Ginnie Mae pools. As of September 2014, there were approximately $5.3 billion of modified loans in Ginnie Mae pools.[49]

Conservatorship of the GSEs

In 2007, Fannie Mae and Freddie Mac reported negative net income. Enactment of the Housing and Economic Recovery Act (HERA) on July 30, 2008, created a new regulator for the GSEs, the Federal Housing Finance Agency (FHFA) and gave the regulator and the Treasury Department additional powers to control and support Fannie Mae and Freddie Mac. During 2008, the capital positions of Fannie Mae and Freddie Mac continued to decline. The FHFA placed the two firms in conservatorship on September 7, 2008. The Treasury purchased senior preferred stock to restore capital. The Federal Reserve announced its Agency Mortgage-Backed Securities Purchase Program in November 2008 and began purchasing agency passthroughs in January 2009. By March 2010, $1.25 trillion had been purchased.[50]

Ongoing Debate over the Role for the Federal Government in Housing Finance

The financial crisis focused attention on the federal government's role in the housing finance system—the specialized institutions like the FHA, Ginnie Mae, and the GSEs; the regulation of private financial institutions such as loan originators; the use of credit ratings to define permissible investments. While there have been many proposals for change put forward by the executive and legislative branches, by representatives of the many industries involved in housing finance, and by academics and public interest groups, consensus has emerged on only a few aspects of the US housing finance system going forward.

Some goals have attracted relatively widespread support. The FHA, VA, and USDA loan insurance and guarantee programs will likely continue, perhaps with changes to eligibility criteria and fees to make those loans financially stable for both borrowers and the government. Because the Ginnie Mae program has relatively little credit exposure, given the guarantees on the underlying mortgages, that program will probably be maintained with little change.

[49] Publicly available data from Ginnie Mae's website. Data are from outstanding fixed-rate 30-year Ginnie Mae pools as of September 2014.

[50] <www.federalreserve.gov/newsevents/reform_mbs.htm>.

The same cannot be said for Fannie Mae and Freddie Mac. To maintain stability in the securities markets, there is general agreement that the existing government guarantee for previously issued agency securities should remain in place, regardless of what happens to the GSEs themselves. Going forward, if there is to be a role for the GSEs, they are likely to be consolidated into a single institution. Detailed proposals have been advanced for a "Single Security" issued through a "Common Securitization Platform."[51] Alternatives being discussed include federal insurance, or coinsurance, to backstop risks to be borne primarily by the private sector.

The liquidity of the TBA market for Ginnie Mae, Fannie Mae, and Freddie Mac passthrough securities has been an important contributor to the extent and efficiency of the US housing finance system, a benefit that non-agency RMBS never had. It is recognized that the Single Security or any post-GSE security should be structured to accommodate TBA trading, although the mechanism for doing so has not yet been worked out.

There is also a widespread view that mortgages should be widely available through channels that do not involve any form of government support. At this writing, the relative costs strongly favor the government-supported channels. To restore and maintain stable private financing will require tuning the eligibility criteria and fees for the government offerings so as to support first-time homebuyers and other socially desirable functions while not crowding out the private sector.

Finally, there is widespread support for a regulatory regime stricter than the one that prevailed prior to the crisis. This topic is covered in Chapter 4.

US Mortgage Finance, Then and Now

The financial crisis drastically changed the housing finance system in the United States, affecting loan originators and securities issuers, banks and government-sponsored enterprises, rating agencies and monoline insurers, prime and subprime borrowers. At this writing, the effects of the crisis are still playing out, and it is not yet clear how homes will be financed in the future. The status of the transition may be summarized as follows:

- Many homeowners are less financially secure because of higher than expected mortgage payments (from an inability to refinance high-rate loans) and/or the loss of equity through declines in housing values and foreclosures.
- Much lending capacity for nonconforming loans, especially subprime, was eliminated as a result of the market's re-evaluation of risk and the loss of home equity to support leverage.

[51] FHFA, "An Update on the Structure of the Single Security" (May 15, 2015).

- Massive intervention by the federal government continues through the FHA and other programs.
- Fannie Mae and Freddie Mac remain in conservatorship even while financing (together with Ginnie Mae) about 85% of mortgage originations since 2008.[52]
- Economic activity as of 2015 had not fully recovered from the subprime crisis.
- Portfolio lending has not grown, with depository institutions slightly reducing their holdings of mortgage loans.[53]
- Outstanding single-family mortgage loan balances decreased 12% between the end of 2007 and the end of 2014,[54] while housing values dropped 2% to 5%, indicating a deleveraging of US households.
- Mortgage securities outstanding have not increased since 2008. Agency securities have grown as non-agency RMBS declined.[55]

APPENDIX

A Chronology of Key Events during the Financial Crisis

October 27, 2006	S&P announced a decline in house prices according to the Case-Shiller index, the first decline in prices following the economic expansion.
February 7, 2007	New Century Financial Corporation, the second largest US subprime lender, announced it was restating its financial reports to show greater subprime loan losses.
March 20, 2007	Two subsidiaries of People's Choice Financial Corporation (a REIT) filed for bankruptcy.
April 2, 2007	Subprime lender New Century filed for bankruptcy.
April 18, 2007	Freddie Mac announced it would buy $20 billion in mortgages in order to prevent loan foreclosures.
June 7, 2007	Bear Stearns announced that it was suspending redemptions from its High-Grade Structured Credit Strategies Enhanced Leverage Fund.
June 14, 2007	Freddie Mac reported a $211 million loss for the first quarter of 2007.
July 10, 2007	Rating agencies began to downgrade or put on their watch lists hundreds of subprime-backed bonds, and announced changes to their rating methods to account for unexpectedly high delinquencies and declining housing prices.

[52] Mortgage Bankers Association, Annual Mortgage Origination Estimates; SIFMA, US Mortgage-Related Securities Issuance.

[53] Federal Reserve Board of Governors, Flow of Funds Accounts (June 11, 2015), table L.218.

[54] Federal Reserve Board of Governors, Flow of Funds Accounts (June 11, 2015), table L.218.

[55] SIFMA, US Mortgage-Related Securities Issuance.

July 17, 2007	Bear Stearns announced that two hedge funds it managed, which were heavily invested in subprime-related assets, had lost almost all of their value.
August 6, 2007	American Home Mortgage, once the tenth largest mortgage lender in the US, declared bankruptcy. Two other lenders, Aegis Mortgage and National City, stopped accepting loan applications.
August 9, 2007	BNP Paribas suspended redemptions for three funds dependent on Asset-Backed Commercial Paper funding following a run on their financing.
August 9–10, 2007	The European Central Bank injected $214 billion into the market. The Federal Reserve Bank of New York said it would buy a total of $62 billion in mortgage-backed, Treasury, and agency securities to provide liquidity for the banking system. The central banks of Australia, Canada, Japan, and Switzerland together added another $16 billion.
August 16, 2007	Moody's downgraded 691 RMBS.
August 16, 2007	Countrywide Mortgage tapped into an $11.5 billion syndicated credit facility as that firm lost access to repo funding.
September 13, 2007	Following a depositor bank run, UK mortgage lender Northern Rock sought emergency funding from the Bank of England.
September 18, 2007	The Federal Reserve Board announced a 50 basis point reduction in the target fed funds rate to 4.75%.
October 11, 2007	Moody's downgraded $33.5 billion of 2006 vintage RMBS.
October 17, 2007	S&P downgraded $23.4 billion of 2007 vintage second-lien and subprime RMBS.
October 31, 2007	The Federal Reserve Board announced a 25 basis point reduction in the target fed funds rate to 4.50%.
November 15, 2007	The Federal Reserve added $47.25 billion in temporary reserves to the banking system.
November 29, 2007	OFHEO announced the first quarterly decline in US house prices since 1994.
December 11, 2007	The Federal Reserve Board announced a 25 basis point reduction in the target fed funds rate to 4.25%.
December 12, 2007	The US Federal Reserve coordinated creation of the Term Auction Facility with four other leading central banks around the world to offer billions of dollars in loans to banks.
January 11, 2008	Bank of America announced the purchase of Countrywide Financial for $4 billion.
January 18, 2008	Ratings agencies began to downgrade mortgage bond insurers. AMBAC was downgraded from AAA to AA by Fitch on January 18, 2008. FGIC was downgraded from AAA to AA by Fitch on January 30, 2008, from AAA to AA by Standard & Poor's on January 31, 2008, from AAA to A3 by Moody's on February 14, 2008, and further downgraded to A by Standard & Poor's on February 25. XL was downgraded to A3 by Moody's on February 7, 2008, and to A minus by Standard & Poor's on February 25.

January 22, 2008	The Federal Reserve Board announced a 75 basis point reduction in the target fed funds rate to 3.50%.
January 30, 2008	The Federal Reserve Board announced a 50 basis point reduction in the target fed funds rate to 3.00%.
February 13, 2008	The maximum size of loans eligible to be purchased or securitized by Fannie Mae and Freddie Mac (the conforming loan limit) was increased temporarily under the Economic Stimulus Act.
February 27, 2008	Federal government allowed Fannie Mae and Freddie Mac to increase their asset portfolios above prior limits.
March 11, 2008	Federal Reserve made $200 billion of funds available to banks and other institutions to improve liquidity in the markets through the Term Securities Lending Facility.
March 16, 2008	JP Morgan Chase announced that it would acquire Bear Stearns.
March 18, 2008	The Federal Reserve Board announced a 75 basis point reduction in the target fed funds rate to 2.25%.
April 30, 2008	The Federal Reserve Board announced a 25 basis point reduction in the target fed funds rate to 2.00%.
July 30, 2008	The Housing and Economic Recovery Act of 2008 (HERA) replaced OFHEO with the FHFA as the regulator of Fannie Mae and Freddie Mac; permanently increased the Fannie Mae, Freddie Mac, Ginnie Mae, FHA, and VA loan limits; and temporarily gave the US Treasury authority to buy debt securities and equity of Fannie Mae and Freddie Mac.
September 7, 2008	The FHFA placed Fannie Mae and Freddie Mac into conservatorship.
September 14, 2008	Lehman Brothers declared bankruptcy. Bank of America announced that it would acquire Merrill Lynch.
September 16, 2008	The Federal Reserve provided a credit facility to American International Group (AIG).
September 21, 2008	Goldman Sachs and Morgan Stanley were approved as bank holding companies.
September 25, 2008	Washington Mutual, with $307 billion of assets, was seized by federal regulators, becoming the largest thrift failure in history; its banking operations were sold for $1.9 billion to J.P. Morgan.
October 3, 2008	Congress passed the $700 billion bailout plan.
October 7, 2008	The Federal Reserve Board announced creation of the Commercial Paper Funding Facility to provide liquidity to issuers of commercial paper.
October 8, 2008	The Federal Reserve Board announced a 50 basis point reduction in the target fed funds rate to 1.50%.
October 8, 2008	The British Treasury announced a £500 billion bank rescue package.
October 12, 2008	Wells Fargo's purchase of Wachovia was approved.
October 13, 2008	The British government announced a £37 billion recapitalization plan, as the rest of the Eurozone announced similar plans.
October 14, 2008	US government announced a plan to buy $250 billion stake in US banks to restore confidence.

October 17, 2008	European Union leaders agreed on a joint $2.7 trillion bank bailout.
October 19, 2008	South Korea announced a $130 billion rescue package to stabilize its markets.
October 20, 2008	Sweden's government announced bank rescue plan with credit of up to $205 billion available.
October 21, 2008	The Federal Reserve Board announced creation of the Money Market Investor Funding Facility in order to provide money market investors with liquidity.
October 28, 2008	US Treasury Department purchased $125 billion in preferred stock in nine US banks under the Capital Purchase Program.
October 29, 2008	The Federal Reserve Board announced a 50 basis point reduction in the target fed funds rate to 1.00%.
November 6, 2008	Bank of England cut rates 150 basis points to 3%, while the European Central Bank cut rates 50 basis points to 3.25%.
November 9, 2008	China announced a $586 billion stimulus package.
November 10, 2008	US government used $40 billion of TARP funding to invest in AIG, bringing their total exposure to $150 billion.
November 23, 2008	Citigroup received an asset-relief package worth $306 billion and a further $20 billion recapitalization.
November 25, 2008	The Federal Reserve announced a program to buy up to $500 billion in agency mortgage securities and $100 billion in agency debt securities.
November 25, 2008	The European Commission announced a recovery plan worth €200 billion, while the US government pledged $800 billion to help the economy including $200 billion in financing from the Federal Reserve.
December 4, 2008	Bank of England cut rates 100 basis points to 2%, while the European Central Bank cut rates by 75 basis points to 2.5%.
December 6, 2008	Germany approved a $39.6 billion stimulus program.
December 16, 2008	The Federal Reserve Board announced a target fed funds rate of 0 to 0.25%.

Key Points

- Subprime lending and non-agency RMBS evolved out of institutional changes at the lender level and policy initiatives aimed at increasing home ownership in lower-income areas. Almost by definition, these mortgages had to be riskier than traditional loans in order to serve this market.
- Non-agency RMBS facilitated origination of subprime and other nonconforming mortgages. Investors were attracted to the relatively higher yields compared to other bonds of similar ratings and maturities. Holders of non-agency RMBS included banks and thrifts, GSEs, broker-dealers.
- Mortgage performance deteriorated beginning in 2006 as the housing market and broader economic conditions declined.
- Subprime mortgage originations declined rapidly as originators failed or otherwise exited the market, and lack of house price appreciation made borrowing more difficult. Prices of non-agency RMBS declined and bonds were downgraded.

- As financial companies deleveraged in response to falling asset prices, the subprime losses resulted in a systemic impact. Several factors contributed to the outcome, including incorrect assumptions that regional house price movements would not be highly correlated and house prices would not fall substantially, as well as declining underwriting standards, and reliance on leveraged holders.
- As the non-agency RMBS market collapsed, the GSEs and the FHA continued to fund mortgage origination. As losses from loan guarantees and declining asset values threatened the GSEs' solvency, the federal government took them into conservatorship.
- The government also enacted a number of policies aimed at helping homeowners avoid foreclosure and provide liquidity to the mortgage market.
- As the effects of the crisis on the housing market subside, policymakers are revisiting the issue of the long-term role of the government in the housing market, but as yet there is no consensus.

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PART II

AGENCY RMBS: BASIC PRODUCTS

CHAPTER 6

AGENCY MORTGAGE PASSTHROUGH SECURITIES

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After reading this chapter you will understand:

- what a mortgage passthrough security is;
- the difference between conventional pools (FNMA and FHLMC) and GNMA pools and their respective guarantees;
- the basics of pooling and estimating passthrough cash flows as well as the application of the Public Securities Association (PSA) model in the valuation of the pools and newly issued Collateralized Mortgage Obligations (CMOs);
- the concept of the current coupon, the coupon stack, and impact of cash flow variability on the yield and average life of the current coupon as well as across the coupon stack;
- how to measure a pool's potential prepayment risk;
- what a dollar roll is and how it is used to finance positions;
- how to identify various specified pools.

Mortgage passthrough securities (or simply passthroughs) represent ownership interests in pools of residential mortgage loans secured by single-family homes (one- to four-family units). Principal and interest payments are "passed through" to the owners of the pool on a pro rata basis, with the proviso that a small portion of the interest is held back by the issuer/servicer to cover any fees. Although there are agency and non-agency passthroughs, the latter are far less common. Two main factors have contributed to the initial success and subsequent massive growth of the agency passthrough programs: (1) the guarantee of timely payment of principal and interest and (2) the high degree of standardization imparted to the securities.

Generally, the market classifies agency passthroughs into two groups:

- Pools guaranteed by Ginnie Mae and backed by government-insured or -guaranteed loans.

- Pools guaranteed by Freddie Mac and Fannie Mae and backed by "conventional" mortgages that "conform" to the government-sponsored enterprises' (GSEs') loan amount and underwriting standards—although not explicitly government-guaranteed, conventional pools were generally trusted to be so, an assumption which proved correct following the financial collapse of both Fannie Mae and Freddie Mac during September 2008.

In this chapter, our focus is on agency passthrough securities issued under the programs of three entities, one federal sponsored agency (Ginnie Mae) and two GSEs (Fannie Mae and Freddie Mac). Chapter 1 covered the history and development of the US mortgage loans and mortgage-backed securities (MBS) markets as well as key operations of the various facets of the markets. The fundamental investment features of agency passthroughs were explained. In this chapter, we look more closely at agency passthrough securities—the basic input of the agency structured securities market. Moreover, we introduce other concepts needed to understand MBS in general which will be covered in the chapters that follow. To begin, both federally sponsored and government-sponsored agency passthrough MBS are legally organized as grantor trusts. Thus, principal and interest are said to be "passed through" to the security holders in the pool with the proviso that a small portion of the interest is held back by the issuer/servicer to cover administration expenses and guarantee fees. The guarantee fees represent an insurance fee charged by the sponsor of the program from whom the security is issued. The amount of this servicing "strip" varies across agency programs. In order to facilitate payment to the investor, a delay necessarily occurs between the payment date on the underlying mortgages and the date upon which the aggregated payments are passed through to security holders; the length of the payment delay varies depending on the agency.

Federally Sponsored Passthrough Programs

Government loans, those guaranteed by the Federal Housing Administration (FHA), may be prepaid at any time without penalty to the borrower. However, in contrast to most non-government or *conventional* loans, they generally need not be repaid in full when the house is sold but instead may be *assumed* by a new buyer. The objective of the eligible federal residential loan programs is to expand housing finance to targeted groups. The FHA program is geared to first-time and other buyers with limited resources for the down-payment, as well as those with less pristine credit histories than those which are required by prime conventional lenders. The most notable differences are:

- In the case of a purchase mortgage, the borrower may finance 96.5% of the purchase price; in return, they pay an upfront insurance premium—often referred to as the upfront mortgage insurance premium (MIP) which may be capitalized as principal at origination. Additionally, borrowers may pay an annual mortgage insurance premium—the ongoing MIP.

- Government loans are subject to dollar limits that are reviewed annually. For example, in 2005, FHA loan limits on one-unit single-family houses ranged from $160,176 to $290,319, depending on location; the maximum original loan amount on a Veterans Administration (VA) loan that may be pooled is $359,650.

Demand for government loans—or perhaps lenders' willingness to make them—declined dramatically with the growth of private subprime lending between 2000 and 2008 at which time the issuance of GNMA securities significantly declined. However, following the collapse of the housing market in 2008 the issuance of GNMA-backed pools has enjoyed a resurgence due to both the explicit government guarantee and also a lack of investor willingness to fund self-insuring subprime mortgage transactions.

Conventional loans, in contrast, are made to borrowers with relatively stronger credit profiles. They are generally due on sale and freely prepayable at any time without penalty to the borrower (exceptions would be pooled separately). Only loans within the conforming loan limit (in practice, the same at both GSEs) may be included. For 2014, the maximum loan limit in geographic regions which were not considered higher cost was $417,000. For geographic areas considered high cost the maximum loan limit was $625,000. Fannie Mae and Freddie Mac actively compete for business from the same group of residential mortgage lenders. Likewise, they securitize from the same stock of conventional loans to borrowers with good credit histories under very similar underwriting criteria. Loan approval mechanisms are now predominantly automated and model-based, making direct comparison of underwriting criteria difficult. However, the array of loan characteristics disclosed at the loan level and aggregated across broad groupings of the GSEs' passthroughs suggests that Fannie Mae and Freddie Mac passthroughs continue to be generally fungible.

The agencies enjoy different ties to the US government. Ginnie Mae is an agency in the Department of Housing and Urban Development (HUD); its guarantee carries the full faith and credit of the US government. By contrast, Freddie Mac and Fannie Mae are GSEs, created pursuant to government housing policy. They exist as federally chartered for-profit corporations (their stock is traded on the New York Stock Exchange) that are taxed at the full corporate rate and are regulated by the federal government. As such, their guarantee does not carry the full faith and credit of the US government. Instead, it is backed by emergency drawing rights on the US Treasury. However, the credit rating agencies consider Freddie Mac and Fannie Mae securities to be eligible collateral for triple-A securities "due to their close ties with the US government." The market generally treats "Freddies" and "Fannies" as if they were triple-A or government agency issues.

Ginnie Mae

Ginnie Mae pools are composed only of loans insured or guaranteed by a small number of federal programs. Eligible loans are those originated under specific programs of the

FHA, the VA, and the Department of Agriculture under the Rural Housing Service (RHS) program, as well as those guaranteed by the Secretary of Housing and Urban Development (HUD) under Section 184 of the Housing and Community Development Act of 1992 and administered by the Office of Public and Indian Housing (PIH). However, almost all loans backing Ginnie Mae pools are FHA and VA loans, and the FHA loans are the vast majority of those.

Ginnie Mae MBS Programs

Ginnie Mae administers two primary agency passthrough programs, the original Ginnie Mae program, GNMA I, in existence since 1970, and Ginnie Mae II, established in 1983. The guarantee is essentially the same under both programs and provides for timely payment of current monthly interest and scheduled principal, as well as unscheduled principal repayments. Since mid-2015, GNMA has been soliciting market feedback regarding the retirement of the GNMA I program.

The GNMA I program yields the most highly standardized, homogeneous MBS in the marketplace. All mortgages in a pool must be the same type (e.g., single-family level-payment fixed-rate), issued by the same issuer, and carrying the same mortgage rate. Fifty basis points of servicing and guarantee fee are "stripped," or retained by the issuer/servicer, resulting in a security paying a coupon 0.5% less than the underlying mortgage rates. Payments on GNMA I MBS are made directly to investors by the issuer/servicer with a stated 14-day delay (i.e., payment is made on the fifteenth day of each month). The minimum pool size is generally $1 million.

The mortgages must have a first payment date no more than 48 months before the issue date of the securities. Likewise, 80% of the loans must have original maturities within 30 months of the latest maturity. Additionally, 90% must have maturities of 20 years or more. An exception permits loans with maturities of less than 20 years so long as 90% have the same term and special disclosure procedures are followed. Also, mortgages must begin amortizing by the month following the month in which the pool is issued. (Age and maturity requirements for GNMA I pools generally apply to GNMA II pools as well.)

Certain single-family government mortgages are segregated into specific Ginnie I pool types.[1]

The vast majority are single-family, level-payment mortgages (pool type SF), and upwards of 90% of those have 30-year terms. In addition, there are small amounts outstanding (which come to less than $200 million) in pools of buydown mortgages (BD; the payment is "bought down" by a builder or developer, but a small amount may be included in standard SF pools subject to disclosure requirements). Programs exist for graduated payment mortgages (GPM) and growing-equity mortgages (GEM) as well,

[1] In addition, Ginnie Mae guarantees pools of FHA-insured construction and permanent loans on "projects" such as multifamily buildings, hospitals, nursing homes, and group practice facilities. These tend to trade in the CMBS market, along with Fannie Mae and Freddie Mac multifamily-loan-backed securities.

but borrower demand for these loan types is light. Likewise, a program is available for manufactured-home loans, but private lenders now dominate this market.

The GNMA II program allows multiple-issuer pools to be assembled, thereby allowing for larger and more geographically dispersed pools, as well as the securitization of smaller loan packages. A wider range of underlying mortgage rates is permitted in a GNMA II MBS pool, and issuers are permitted to take greater servicing fees—ranging from 25 to 75 basis points. It follows, then, that the rates on the underlying mortgages may lie within a 50 basis points range (in contrast to the Ginnie I requirement that they all be the same).[2] The minimum pool size is $250,000 for multi-lender pools and $1 million for single-lender pools. Payments on GNMA II MBS are consolidated by a central paying agent; this arrangement necessitates an additional five-day payment delay (payment is made on the twentieth day of each month).

Single-family, level-pay (SF) loans are also the dominant loan type securitized under GNMA II pooling rules. Government ARM loans are securitized exclusively as GNMA IIs. In addition, the GNMA II program is a more important outlet for buydown pools. Of lesser importance are programs for GPM, GEM, and manufactured-home loans.

Investors tend to prefer larger pools. In addition, below a certain remaining principal amount, pools may suffer from a lack of liquidity. Accordingly, following the lead of the GSEs, Ginnie Mae added a Platinum pool option under its CMO (multi-class) program. This option allows investors to recombine smaller pools that have uniform coupons and original terms to maturity into a single certificate in amounts of $10 million or more. This is a useful strategy to improve the liquidity of small or paid-down pools because it consolidates payments on the underlying pools. In addition, the Platinum repooling option also appeals to those investors seeking to reduce both accounting and administrative costs.

Freddie Mac Participation Certificates

Freddie Mac refers to its passthroughs as "participation certificates" (PCs). Prior to June 1990, PCs generally were issued with "modified" guarantees, and they all had 44-day payment delays. A modified guarantee provides timely payment of interest and eventual payment of principal. These securities are now referred to as the "75-day delay PCs" because payment is remitted to the investor on day 45 (plus the fact that mortgage payments are made 30 days in arrears—a 75-day delay).

In 1990, Freddie Mac announced the Gold program for fixed-rate mortgages,[3] which shortened the delay to 44 days (standard 30-day delay on the underlying mortgage payment plus a 14-day delay, payment made on the fifteenth day of the month), equivalent to the Ginnie Mae payment cycle. Also, Freddie Mac upgraded the guarantee. The Gold guarantee provides for timely payment of interest and scheduled principal and ultimate

[2] Before July 1, 2003, loan rates were permitted to vary within a 1% range.

[3] ARM PCs have different guarantee, delay, and pooling characteristics.

payment of all principal without offset or deduction. It stopped issuing the 75-day PCs and allowed holders to exchange outstanding 75-day PCs for Gold PCs without fee (although holders paid the difference in price owing to a 30-day shorter delay). Given conversions, the passage of time, three massive prepayment waves and the Home Affordable Refinance Program (HARP) since, only a small amount of the 75-day delay securities remain outstanding.

At one time, within the 75-day delay and Gold programs, Freddie Mac also distinguished between cash and guarantor programs. The earliest Freddie Mac PCs were created as "cash" pools. That is, Freddie Mac bought loans underwritten to its guidelines from originators at its "cash window" (now called the whole-loan desk) and issued PCs in $50 million minimum sizes. Like Fannie Mae (discussed in the next section), it instituted a "guarantor" program in the early 1980s in which it guaranteed pools of loans underwritten to its guidelines that then could be sold by the lenders to broker-dealers. The actual transaction entails swapping the PC for the loans (hence they were also known as "swap" pools). The program quickly gained popularity with thrifts and mortgage bankers growing to account for the bulk of Freddie Mac passthrough production. Freddie Mac dropped the distinction between cash and guarantor pools in 1994; as of mid-2015, those pools which are collateralized by loans purchased on the part of the whole loan desk are identified by the seller field in the pool information which is transmitted by the agency to broker-dealers, third-party data vendors, and other market participants.

The pooling criteria for Gold PCs has evolved over the years. As of mid-2015, the interest rates on the underlying mortgages may range between the PC coupon plus any minimum required servicing fee (25 basis points currently) and 250 basis points above the PC coupon. Loans may be of any age.

The dominant PC sectors are 30-year and 15-year standard conventional level-pay loans on single-family (one- to four-family) dwellings. Fifteen-year mortgages are pooled separately from 30-year mortgages. Ten-year mortgages may be pooled separately or with 15-year mortgages; 20-year mortgages may be pooled separately or with 30-year mortgages. Balloon mortgages, modifiable mortgages, interest-only (IO) mortgages, prepayment penalty, and FHA/VA mortgages are pooled separately. Finally, although they may be pooled separately, up to 10% of the conventional mortgages in a standard PC pool (by original principal balance) may be cooperative-share, buydown, or relocation mortgages, so long as the combination of these types does not exceed 15% of the original principal balance. Separately pooled loan types are indicated by pool prefixes; the broad array of prefixes is modified periodically by discontinuation and additions.[4]

The minimum pool size for fixed-rate Gold PCs is generally $1 million. Freddie Mac also allows investors to combine pools of the same type and coupon in Giant PCs. The minimum pool size for a pool backing Giant PCs is $1 million. The agency's website,

[4] The PC Prefix Guide on <www.freddiemac.com> lists 27 categories of Gold PCs and 29 of ARM PCs.

<www.freddiemac.com>, is an excellent source of additional information on its passthrough programs, including current offering circulars (similar to prospectuses), current lists of frequently used pool prefixes, and so forth.

Fannie Mae MBS

Fannie Mae (like Freddie Mac) permits the pooling of a much broader array of mortgage types than are available under government loan programs and pooled in Ginnie Mae securities. While the dominant programs are standard fully amortizing 30- and 15-year level-payment loans (on one- to four-unit single-family dwellings, indicated by pool prefixes CL and CI, respectively), a full array of other loan types, including ARM, IO (over an initial period), balloon, biweekly, graduated-payment, growing-equity, relocation,[5] cooperative-share, and buydown mortgages, are pooled separately.

The Single-Family MBS Prospectus lists 32 frequently used pool prefixes for fixed-rate and ARM pools, whereas the comprehensive Pool Prefix Glossary on <www.fanniemae.com> lists over 130. Fannie Mae's guarantee provides for the timely payment of interest and scheduled principal and full payment of all principal by the maturity date.

Underlying mortgage rates may range from 25 to 200 basis points above the passthrough coupon rate, and mortgages of any age may be pooled. For fixed-rate programs, minimum pool size is $1 million.

The Fannie Majors program allows multiple (and single) lenders to form large pools composed of a single mortgage loan type originated within 12 months of the issue date. Fannie Majors pools usually exceed $200 million at issuance, and some are larger than $500 million. The program is available for groups of fixed-rate (10-, 15-, 20-, and 30-year) mortgages, 7-year balloons, and ARMs. Fannie Majors pools are identified by the same prefixes assigned to their single-lender pool counterparts.

For a fee, Fannie Mae also permits investors to exchange a group of passthroughs of the same type and coupon for a single Mega certificate in amounts of $10 million and up.

Agency Passthrough Cash Flows

Evaluating the investment characteristics and performance of passthroughs requires an understanding of pool structure and the cash flows generated. Moreover, the pool cash flow will be used for understanding an agency multi-class MBS (agency collateralized mortgage obligations and mortgage strips). Accordingly, we begin with the most common case, a pool of 30-year, level-payment, fully amortizing, fixed-rate mortgages.

[5] Relocation loans may be included in standard Fannie Mae MBS so long as they do not exceed 10% of the original aggregate balance.

Table 6.1 Sample passthrough pool

Loan Amt ($k)	Rate (%)	Age	Rem Term (mths)	Pool Cpn (%)	Servicing (%)
200	5.578	2	358	5	0.578
180	5.678	1	359	5	0.678
150	5.275	4	356	5	0.275
250	5.500	3	357	5	0.500
220	5.250	5	355	5	0.250
P/T WAVG	**5.459**	**3**	**357**	**5**	**0.459**

We do not present the cash flow mathematics here. The formulas for obtaining the cash flows are provided in Chapter 3.

A simplified example of this type of loan pool is shown in Table 6.1. Five mortgages in different original loan amounts with different interest rates—by convention called coupons—are pooled to create a $1 million pool. From them, varying amounts of interest are stripped to create a 5% coupon and are retained to compensate the servicer for administrating the pool and to pay guarantee fees. That is, 57.8 basis points servicing is stripped from loan 1, 67.8 basis points from loan 2, and so forth. Note that the figure could apply equally to a Fannie Mae, Freddie Mac, or Ginnie II pool.[6]

Standard 30-year fixed-rate mortgages are repaid in equal monthly installments of principal and interest (hence the term *level payment*). The payment amount is determined such that for a given interest rate, principal payments retire the loan as of the final payment date. In the early years, most of the monthly installment consists of interest. Over time, the interest portion of each payment declines as the principal balance declines until, closer to maturity, almost all of each payment is that of principal.

By convention,[7] the market estimates scheduled cash flows on a mortgage pool by treating the pool as if it were a single mortgage. That is, all the mortgages are assumed to have the same interest rates and maturities. Specifically, we use the pool's dollar *weighted-average underlying loan coupon* (WAC), and *weighted average remaining maturity* (WAM) to estimate scheduled cash flows.[8] The 5% passthrough in Table 6.1 has a WAC of 5.4589% and a WAM of 357 months (or 29 years and 9 months). Assuming no prepayments, projected interest, scheduled amortization, and servicing are depicted in Figure 6.1.

[6] Recall from the preceding discussion that if the example were a 5% GNMA I pool, all the loans would have the same rate, 5.50%.

[7] The conventions for formulas, documentation, clearance, and settlement of MBS and related securities (including CMBS and ABS) are detailed in Uniform Practices, developed and published by the Bond Market Association (now the Securities Industry and Financial Markets Association, SIFMA).

[8] The WAC and WAM are computed using as weights the principal amount outstanding. Sometimes the WAC is referred to as the pool's "gross WAC," and the pool coupon rate is referred to as the "net WAC."

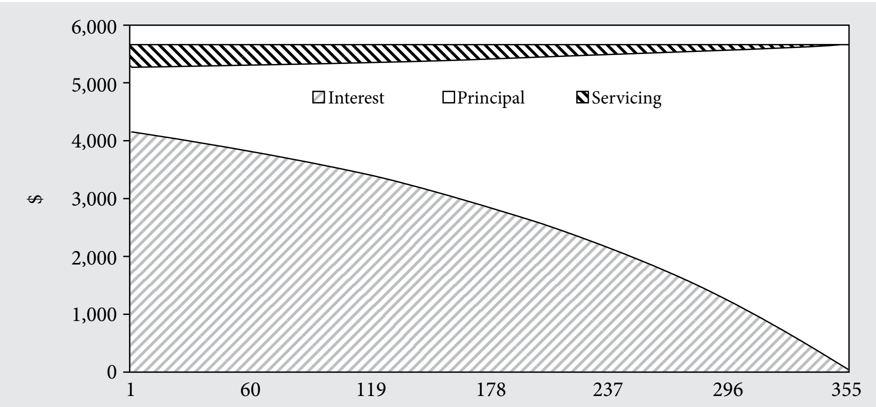

FIGURE 6.1 Cash flows on sample pool at 0 prepayments
Note: $1 mm pool of 5.4589%, 30-year mortgages, and a 5% passthrough certificate. Assumes no prepays.

As we would expect, without prepayments, the total flows off the pool are level, and the cash flows to investors slowly creep up over time as servicing flows diminish. Likewise, passthrough interest decreases as principal is paid down and a larger portion of the fixed payment can be allocated to amortization.

Note that the market is "estimating" cash flows. The accuracy of projected amortization schedules using WAC and WAM statistics is reduced somewhat when a wide range of coupons, maturities, and seasonings is permitted in a pool. The homogeneity fostered by the agencies' pooling requirements (reviewed earlier) reduces the margin of error. However, some discrepancy arises simply from the fact that amortization is not a "linear" function. Individual loans will be paying principal and interest at different rates depending on their age and the original term of the loan. The aforementioned assumption works less well when loans of different ages and different original terms (e.g., 20-year loans included with 30-year loans) are pooled together. For instance, a 30-year pool can have an original (at issue) WAM of 352 months. If all the loans are 30-year loans, then the average loan age is eight months. If an uncertain number of loans have 20-year terms, then 8 months is only an estimate of the pool's age, creating additional uncertainty in the projected cash flows.

The agencies provide different statistics to help the market resolve some of this uncertainty. The agencies update their WAC and WAM statistics monthly to capture the changing contents of the pool should the investor desire to compute cash flow based on aggregation. However, monthly loan-level transaction data for each pool is also provided by the agencies. Both GNMA and Freddie Mac provide comprehensive loan-level data for most outstanding pools. Fannie Mae provides monthly loan-level transaction data for those pools issued on or after January 2013. The distribution and use of loan-level data greatly enhances the investor's ability to project accurate cash flow assumptions as well as create and apply prepayment models at the loan level.

Incorporating the Possibility of Prepayments

Mortgage prepayments are the central concern for MBS. With the exception of some smaller programs backed by loans with prepayment penalties, the loans collateralizing agency passthroughs may be paid off at any time prior to maturity. More often than not early repayment of the loan is due to the borrower either selling or refinancing the property. The possibility of early re-prepayments means that underlying cash flows cannot be predicted with certainty, giving rise to prepayment risk.

Assumptions must be made concerning the likely prepayment pattern in order to estimate a pool's cash flows. The simplest way of expressing a prepayment assumption is as a fraction of principal at the beginning of the period, when expressed as an annual rate of prepayment; this is called the conditional prepayment rate or *CPR*.[9]

Figure 6.2 depicts the cash flow pattern for the 5%, 30-year passthroughs with a 5.4589% WAC and a 357-month WAM when a fraction of the remaining principal is prepaid each month, in this case a CPR of 10% (denoted 10 CPR). That is, it is assumed that 10% of the principal would prepay over 12 months (i.e., annualized, assuming monthly compounding, or that 0.8742% of the principal prepays per month). The cash flow is no longer level in each month over the period. Instead, cash flows decline continuously from the first month as both unscheduled prepayments and the remaining scheduled principal payments reduce the outstanding principal balance of the pool. In particular, assuming a conditional prepayment rate over the life of the mortgage loans (i.e., a constant CPR) means that the largest prepayment in dollar terms will occur in the first

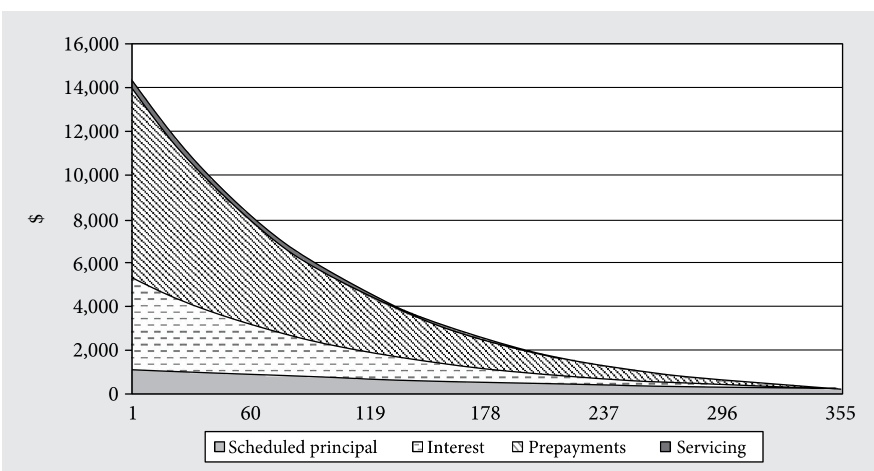

FIGURE 6.2 Cash flows on sample pool at 10 CPR

Note: $1 mm pool of 5.4589%, 30-year mortgages, and a 5% passthrough certificate. Assumes no prepays.

[9] See Chapter 2 for this prepayment measure.

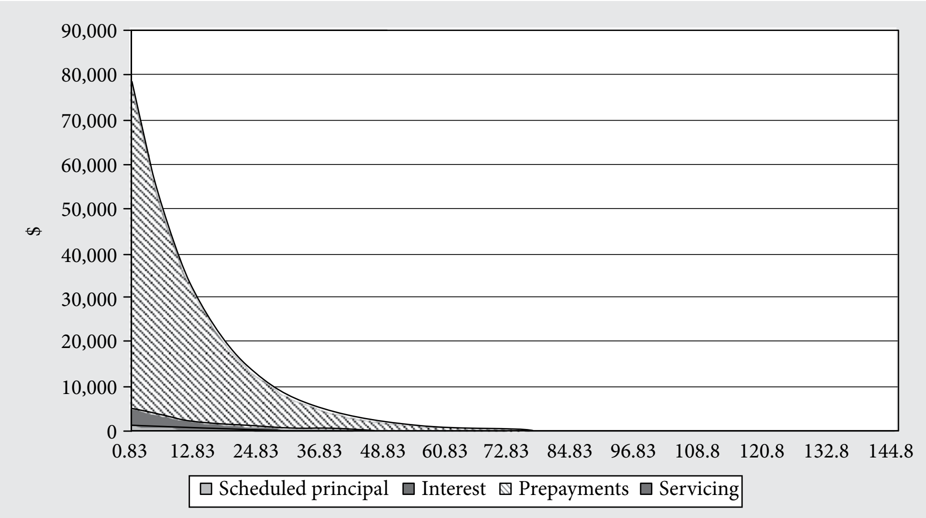

FIGURE 6.3 Cash flows on sample pool at 60 CPR

month. Further, notice that prepayments also lower the total amount of interest paid over the life of the passthrough.

At 10 CPR, half the principal balance is paid down within six years. Nonetheless, some cash flow is received up to the expected maturity of the pool (a WAM is properly an expectation; some mortgages will remain outstanding beyond the WAM). Figure 6.3 illustrates the cash flow pattern at 60 CPR. In this figure, prepayments swamp all other cash flows, and interest payments are sharply reduced. The life of the investment is significantly shortened; over half the principal returns in three quarters, and 90% is paid down in less than 2.5 years.

A constant prepayment assumption (i.e., a CPR that is the same over the passthrough's life) is not realistic. At best, prepayment assumptions or projections one, two, or three months forward may be realistically based on current interest rates or current prepayment speeds. Beyond that window, assuming a constant prepayment rate is comparable to assuming that interest rates will remain at current levels.

The Public Securities Association Prepayment Standard

In the passthrough market, CPR is the standard unit of measurement—particularly in the case of seasoned passthroughs. However, agency passthroughs are regularly "structured" into collateralized mortgage obligations (CMOs)—series of bonds that are solely paid by cash flows from the underlying passthrough (commonly referred to as "collateral," hence the use of the term when referring to passthroughs). When evaluating the cash flow of either a passthrough or a CMO collateralized by newly originated loans it is inappropriate to assume a constant CPR because newly originated loans and pools tend to exhibit very small prepayments in their early months. Indeed, the likelihood of prepayment increases as the loans age; this process is called seasoning. In the sections that follow, we discuss seasoning along with the other important determinants of prepayments.

Recognizing the need for a prepayment standard that incorporates seasoning and that could be used to quantify prepayments of principal for the sole purpose of pricing and analyzing CMOs,[10] MBS research analysts from the various broker-dealers represented by the then-Public Securities Association (PSA)—subsequently the Bond Market Association (now SIFMA)—tackled the problem in the mid-1980s. The result is called the PSA prepayment standard.[11] It calls for a series (or vector) of CPRs defined for 360 months as follows:

- The projected CPR begins at 0.2 CPR and rises linearly by 0.2 CPR per month to month 30 (this is called the *seasoning ramp*).
- Beyond month 30 the projected CPR is a constant 6%.

This CPR path outlined above is said to be 100% of the PSA standard—commonly written as 100 PSA. Figure 6.4 illustrates a comparison between 100 and 350 PSA. The average age of the collateral is used to map the appropriate multiples of PSA; that is, if the collateral has an average age of three months, the CPR for month 4 is the first used in

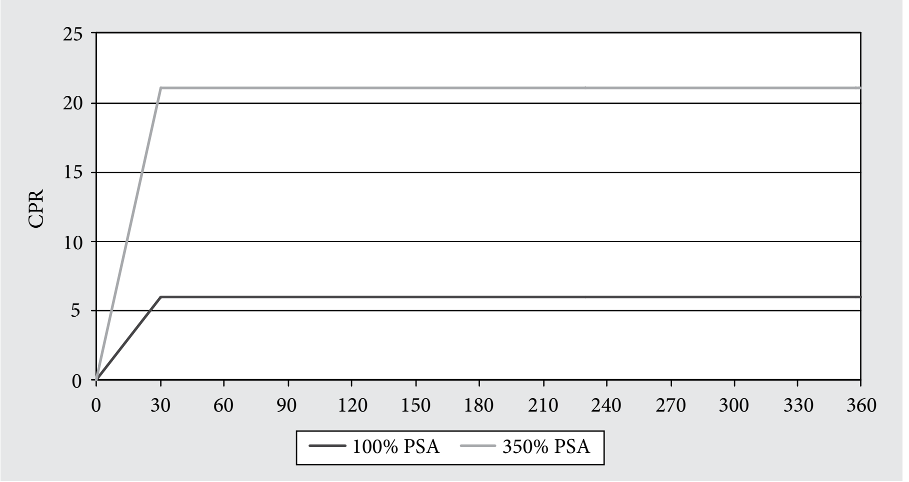

FIGURE 6.4 PSA CMO structuring prepayment assumption

[10] Historical prepayments on passthroughs may be calculated as PSAs, as they are on CMOs, but the numbers are only meaningful in reference to CMO pricing assumptions and to compare specific collateral behind a CMO to a more general passthrough universe. The passthrough market focuses on recent and projected CPRs.

[11] Sometimes the PSA standard is called a model, but this is inflationary language. It was barely based on empirical evidence for FHA loans two decades ago. Today it is convenient rather than reflective of any actual passthrough prepayment behavior.

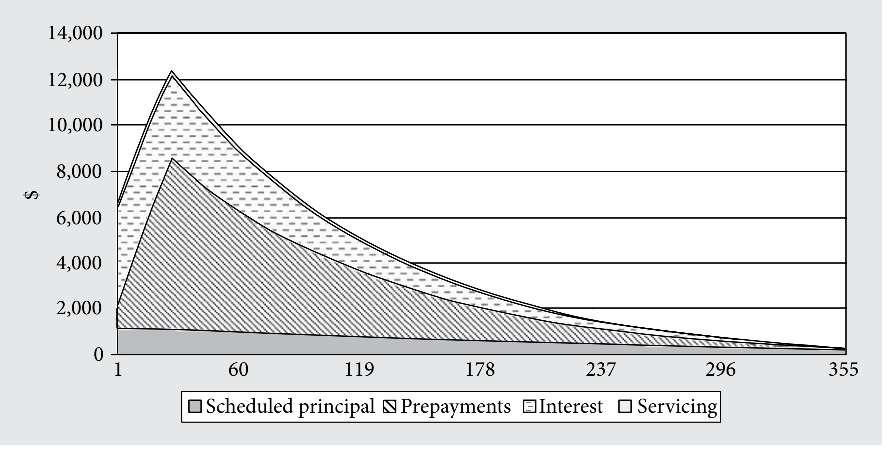

FIGURE 6.5 Cash flows on sample pool at 165 PSA

cash flow projections. Figure 6.5 illustrates projected scheduled principal, prepayments, interest, and servicing on the pool defined in Table 6.1 at a reasonable pricing speed of 165 PSA. The CPR in month 4 is 1.32% ($4 \times 0.02 \times 1.65$).

Using the PSA standard to structure a CMO allows the principal payments to "ramp up" as the collateral ages. If a constant CPR were used, the largest principal payment to bondholders would occur in the first month (as Figures 6.2 and 6.3 illustrate). Consequently, a constant CPR assumption overvalues the first payment tranches while undervaluing the last cash flow tranches.

Impact of Cash Flow Variability on Yield and Average Life

The actual economic performance of a passthrough is a function of the timing and amount of cash flows, on the one hand, and the degree of discount or premium (from par) paid, on the other. We can illustrate this in Table 6.2 by considering the impact of different CPRs on the yield[12] and average life of a 5% passthrough (with a 357-month WAM, similar to the example in Table 6.1, and having a 54-day delay, similar to a Fannie Mae passthrough). Prepayments are varied in CPR in the top half, PSA in the bottom half. The PSA speeds shown correspond to the median of lifetime speeds projected by street broker-dealers and contributed on a regular basis (reflecting changes

[12] Yields shown are *bond-equivalent yields to maturity.* This yield calculation adjusts for the fact that passthrough payments are received monthly, whereas Treasury, agency, and corporate bond interest payments are made semiannually. See "Standard Formulas for the Analysis of Mortgage-Backed Securities and Other Related Securities," *Uniform Practices Manual*, SIFMA.

Table 6.2 Effect of different prepayments on bond equivalent yield of discount current (parity) and premium prices on a 5% passthrough

	6		*10*		*18*		*25*		*35*		*50*		*70*	
CPR	**Yld**	**Avgl**	**Yld**	**Avgl**	**Yld**	**Avgl**	**Yld**	**Avgl**	**Yld**	**Avgl**	**Yld**	**Avgl**	**Yld**	**Avgl**
95–00	5.74	10.4	5.93	7.6	6.37	4.7	6.79	3.4	7.47	2.3	8.68	1.5	10.93	0.9
99–20	5.06		5.06		5.06		5.07		5.07		5.08		5.10	
102–00	4.73		4.64		4.44		4.25		3.94		3.38		2.36	
105–00	4.34		4.14		3.69		3.26		2.58		1.35		–0.90	
+300		***+200***		***+100***		***Flat***		***–100***		***–200***		***–300***		
106		***114***		***126***		***181***		***833***		***1667***		***2299***		
PSA	**Yld**	**Avgl**	**Yld**	**Avgl**	**Yld**	**Avgl**	**Yld**	**Avgl**	**Yld**	**Avgl**	**Yld**	**Avgl**	**Yld**	**Avgl**
95–00	5.72	10.7	5.73	10.34	5.76	9.8	5.89	7.9	7.23	2.4	8.82	1.4	9.84	1.07
99–20	5.06		5.06		5.06		5.06		5.07		5.09		5.09	
102–00	4.74		4.73		4.72		4.66		4.00		3.28		2.80	
105–00	4.36		4.34		4.31		4.18		2.71		1.08		0.02	

in base-case interest rates) to Bloomberg, Inc. (a widely subscribed security and data analytic tool).

The PSA framework shown is the common first step in analyzing a CMO or newly originated passthroughs. However, except by comparison with a CMO, now it is less common to analyze seasoned passthroughs on a price-yield–average-life matrix. We do so to build intuition.

Note, first that the passthrough's average life (defined as the dollar-weighted average time over which the principal is returned) is shorter at successively higher prepayment speeds. (Furthermore, recall from the preceding cash flow figures that the "window" over which principal is expected to be paid shortens around this average life as well.) The shortening, or call risk, is a positive event for the yield of a passthrough when it is purchased at a discount from par. This is due to the fact that principal is returned at par and the sooner principal purchased at a discount is returned, the higher is the yield.

The reverse happens when an investor pays a premium for a passthrough paying an "above-market" coupon. In this case, the longer the principal remains outstanding—due to slower prepayments—and thereby earning greater interest the better the yield over the life of the pool. The faster the prepayment speed, the less likely the investor is to recover the full amount of the premium via interest payments.

The third case is the *parity* or *current coupon* price. If there were no delay (mortgage payments paid at the first of the month and passed immediately to the investor), this price would be 100, and the yield would be equal to the coupon, 5%, at every prepayment rate. Reflecting the 54-day delay in this example, the price is very close to 99-20, the yield a few basis points above the coupon. At this price, the yield is stable despite the speed or average life. At fast speeds, the gain on rapid return of principal compensates for interest foregone; at slow speeds, greater collections of interest compensate for the delay in receipt of principal. In effect, the impact of the prepayment option on yield is neutralized at the parity or current coupon price.

In most interest rate environments, new passthroughs are generally priced close to parity. As a result, another usage of the term *current coupon* refers to the actual coupon priced closest to but below par as the current (production) coupon.

Investors who measure the income from their investments at book yield (banks, insurers, etc., subject to accounting rules designed to reflect changes in prepayment rates) prefer passthroughs priced in a narrow range around par. However, yield does not capture the reinvestment risk imposed by prepayment volatility.[13] The reality of prepayments is that they accelerate when yields are falling, requiring investors to reinvest at lower yields or coupons. When yields rise, the return of principal slows, and investors miss out on better reinvestment opportunities. However, for investors such as life insurers, who might own passthroughs against long liabilities, the rally scenario can be more destructive because net interest margins will shrink as principal is reinvested at lower yields. Banks tend to let short-term funding run off as their MBS are called.

Call and extension are negative as well for investors who mark-to-market. As interest rates drop and prepayments accelerate (or expectations of prepayments) increase, the expected average life or duration of the passthrough contracts. That is, its price sensitivity to declining rates shrinks as it becomes an effectively shorter security. As such, it will underperform noncallable bonds. When rates rise, the passthrough extends and its price declines faster than comparable noncallable bonds. This property of passthroughs (and CMOs constructed from them) is called *negative convexity*.

Negative Convexity and Duration Drift

The negative convexity of passthroughs is directly reflected in their market prices such that prices increase more slowly for each 50 basis point step in coupon above par. This is shown in Figure 6.6 using the 30-year Fannie Mae coupon stack.

Analyses using a constant prepayment assumption are called *static*. As the term implies, they are limited in usefulness; many scenarios need to be compared to arrive at an understanding of the potential variability of a passthrough's cash flows over, for instance, an interest rate cycle. For this reason, market participants prefer to use option-adjusted spread (OAS) or price models that take into account a large sample of potential interest rate paths over the remaining term of the security. The OAS methodology, discussed in Chapter 24, incorporates realistic short-term prepayment projections from sophisticated econometric prepayment models. These models extract a mean cost of call and extension risk over the full term of the security in generating yield, spread, and price sensitivity measures. They are also used to estimate the price sensitivity of passthroughs

[13] Yield-to-maturity calculations assume that cash flow is reinvested at the same rate.

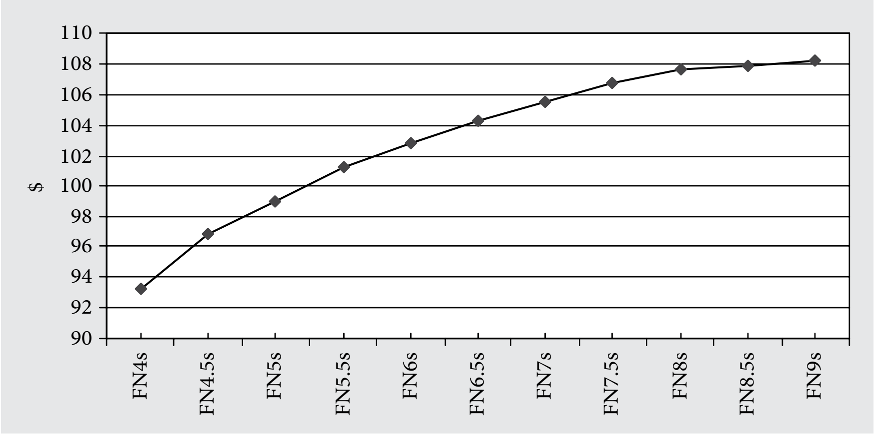

FIGURE 6.6 Negative convexity as coupon price compression

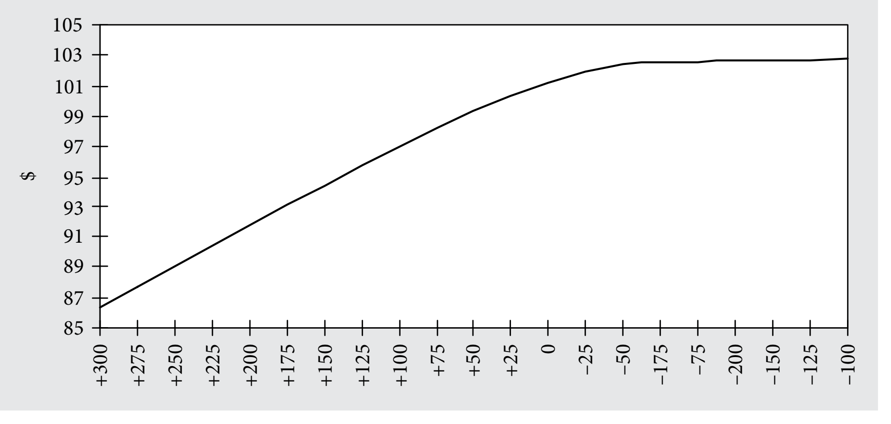

FIGURE 6.7 Negative convexity: Theoretical price sensitivity of a conventional 30-year 5.5, start price 101-7+

to small changes in interest rates—effective durations—or to project price changes and rates of return given either or both interest rate shifts and changes in the shape of the curve.

Figure 6.7 illustrates prices of 30-year Fannie Mae 5.5s over a range of parallel shocks to the yield curve using an OAS methodology. Notice how this price curve captures the same sort of negative convexity actually priced into the Fannie Mae coupon stack.

Figure 6.8 tracks the effective, or option-adjusted duration, of 30-year Fannie Mae 5.5s from January 2003. For reference, the 10-year swap rate ($US) is included. Notice that the duration ranged from one to five years over the period shown. Market participants (broker-dealers, GSEs, hedge funds, and servicers in particular) use durations from OAS models to size their mortgage hedges. It should be clear that in rapidly moving markets, passthrough durations and hedge ratios can shorten or lengthen

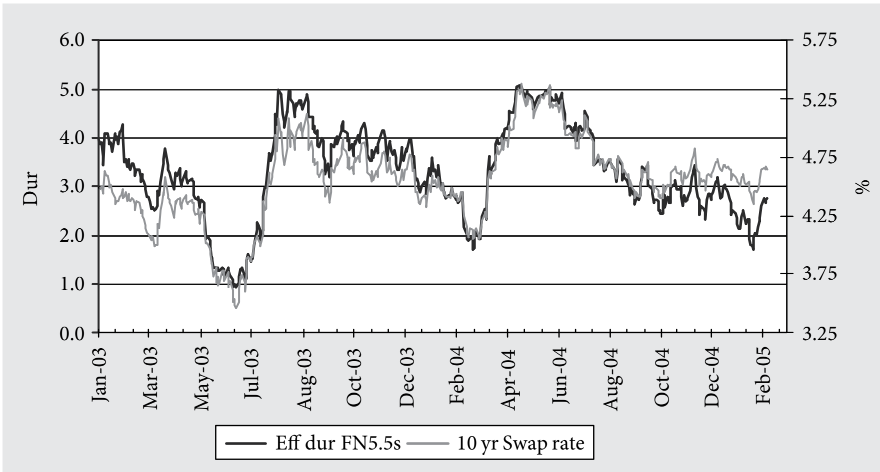

FIGURE 6.8 Duration drift: Effective duration of 30-year FN5.5s and 10-year swap rate

explosively and hedging demand can generate hectic buying or selling of hedges as passthrough investors attempt to adjust their hedges. These flows can add to the speed and extent of both rallies and sell-offs.

Determinants of Prepayment Speeds

Prepayments are the chief determinant of a passthrough's investment performance. The factors described below have been found to impact agency mortgage prepayments and are incorporated into statistical prepayment models.

Over a holding period, the amount of repayment and actual collections of interest are a function of realized prepayments. So too, the price performance of a passthrough is a function of the market's expectations of future prepayments. The causes of prepayments *in full* generally fall under three headings—refinancing, turnover, and default. Homeowners refinance for three reasons:

- To lower their monthly payment by lowering the mortgage interest rate—this is often referred to as a "rate refinance."
- To alter the term of the mortgage refinance from a 30- to 15-year term—this is generally referred to as "rate and term" refinance.
- To extract paid-in equity and/or increases in appraised home value due to appreciation—this is often referred to as a "cash-out refinance."

MBS market participants typically refer to prepayments occasioned by the sale of the house as "turnover." Finally, a default can result in a prepayment when the servicer forecloses on the mortgage and sells the property. A borrower default may be of two kinds:

- Strategic default, the borrower holds—especially in the case of a high loan-to-value—a put option to the lender. A precipitous decline in home prices whereby the borrower is underwater—the value of the home is less than the balance of the loan outstanding—may trigger a default.
- A life event, typically a jobless or serious illness.

Investors are protected from any loss that might occur on foreclosure and sale by the passthrough guarantee. In addition to prepayments in full, borrowers may partially prepay their loans at any time. This is referred to as a "curtailment" and has the effect of shortening the final maturity of a level-payment loan.

Refinancing

To varying degrees, all the sources of prepayments in pools are interest-rate-sensitive, but the most variable source of prepayments is refinancing. In theory, a rate refinance occurs when the difference in monthly payment between the current note rate and prevailing mortgage rate is sufficient enough to permit the homeowner to recover the loan fees and points, as well as the legal, appraisal, title-related, and other costs of refinancing over some reasonable period of time. In the 1980s, a commonly invoked rule of thumb estimated that the minimum incentive was a 200-basis-point interest rate savings. Aggressive competition among lenders, innovation, and technological advances have shaved closing costs, simplified paperwork, and cut approval times dramatically. The reductions in the cost and "hassle" of obtaining a mortgage began to be evident in the early 1990s, as mortgage bankers stepped into the breach left by the collapse of the thrift industry, and accelerated as the decade progressed. Today, market participants estimate that an interest rate saving as small as 25 basis points may be sufficient to trigger a refinance. Indeed, declining transaction costs and originator efficiency have multiplied the refinancing response to a given interest rate decline.

Turnover

Intuitively, turnover is interest-rate-sensitive in the sense that houses are easier to sell when interest rates are declining or low. (Note, however, that turnover is not directly indicated by the pace of existing home sales. Those numbers need to be adjusted for existing housing stock, which generally increases as new homes are built.) However, the level of interest rates is only one of several factors that determine housing affordability and hence the level of turnover. Household income and housing prices are significant as well and tend to offset somewhat the impact of rising interest rates. That is, improving economic conditions, along with rising employment and incomes, tend to accompany upward pressure on interest rates. Somewhat conversely, rapid home sales tend to be accompanied by rising home prices, diminishing affordability to some degree. By the same token, rising mortgage rates may slow home price appreciation, keeping home prices within reach.

Some degree of turnover takes place even in high-interest-rate environments. Seasonality is an important characteristic of turnover, with peak home sales occurring in the summer and troughs typically occurring in the winter. Weather is a factor, at least in northern states, because house hunting and moving are easier in good weather and houses “show” better in good weather. Also, households with children prefer to move between school years. Understandably, the seasonality of prepayments has a more demonstrable impact on passthrough cash flows in high-interest-rate environments, when refinancings are at a low ebb. Likewise, it dominates perception of value in high-rate, low-refi environments.

Defaults

Given the historically strong credit performance of prime conventional loans prior to the collapse of the US residential housing market in 2008, defaults generally were ignored as a component of prepayments in conventional pools. Following the conservatorship of FNMA and FHLMC, as well the decline in home prices and the subsequent defaults, investors now pay greater attention to agency MBS default and buyout rates. Figure 6.9 provides a comparison of the “90 days past due” delinquency rates between FHLMC and GNMA II single-family 30-year passthroughs. The GNMA delinquency data, a longer time series, is instructive: following the decline in home prices, the 90 days past due delinquency rate increased to a peak of 5.0%. FHLMC’s 90 days past due delinquency rate, reported since December 2010, began at 37 basis points and has steadily declined 7 basis points as of June 2015, reflecting a general recovery in the

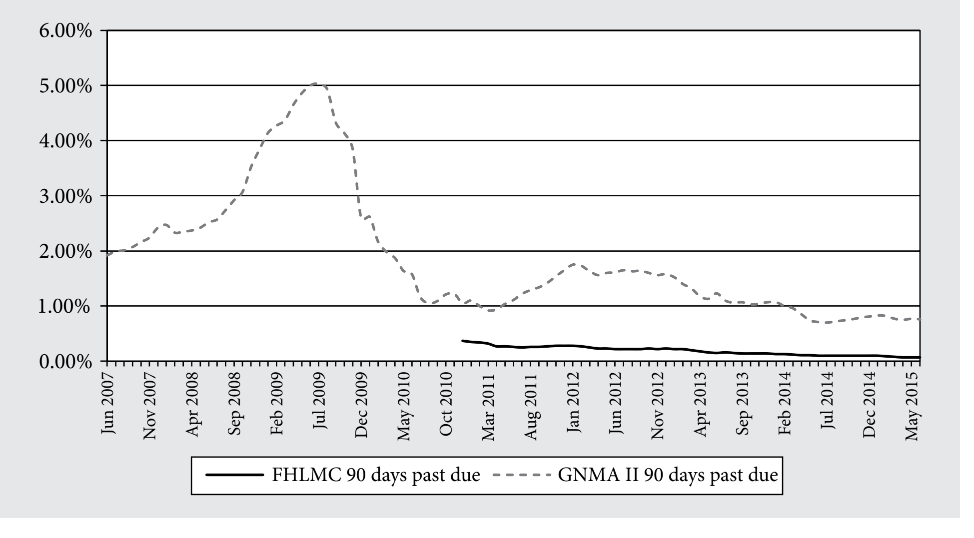

FIGURE 6.9 Relative delinquencies between FHLMC and GNMA II programs

Source: CPRCDR Alpha

housing market as well as tighter underwriting standards. Further, notice that GNMA II buyout rates are multiples of those of FHLMC, reflecting the weaker underwriting standards of GNMA relative to either FHLMC or FNMA. Indeed, the respective delinquency rates of FHLMC (0.07%) and GNMA II (0.76%) imply conditional buyout rates (CBR) of 0.8 and 8.7.

Ginnie Mae permits servicers to buy delinquent FHA and VA loans out of pools (at par) under certain circumstances. These loans can be resecuritized as private CMOs, Fannie Mae or Freddie Mac guaranteed securities, repooled if the loans become current again, or "reperform." FHLMC securitizes its reperforming loans under the R pool prefix. As a result of the ability to securitize reperforming loans, servicers have an incentive to buy out eligible loans having premium coupons in the hope of reselling them at a gain over par. This activity has had a discernible impact on prepayments in premium coupons particularly in the GNMA sector, generating prepayment spikes on a periodic basis.

Gauging a Pool's Prepayment Risk

From the outset, market participants used the WAC as the primary indicator of a pool's prepayment risk and the average age of the loans as a secondary indicator. Comparing the WAC to current mortgage rates provides a shorthand measure of the borrowers' refinance incentive. To the degree that the WAC is higher than the market rate, the underlying borrowers have, on average, a positive incentive to refinance. Pools with WACs equal to or below the current market rate generally reflect turnover and cash-out refinancing activity (there also might be a positive rate incentive between a fixed-rate and adjustable-rate mortgage). Thus, it follows that the passthrough coupon is a rough indicator of refinancing risk (but servicing varies across programs and across pools within all but the GNMA I program, so relative value among passthroughs requires that differences in WAC be taken into account.)

The WAM (because term minus WAM yields an estimate of weighted-average age) indicates the age or *seasoning* of a passthrough. Ginnie Mae and Freddie Mac also provide updated weighted-average age (WALA) for more precise measures of age. The degree of seasoning generally indicates the borrower's willingness to refinance. That is, some period of time normally must pass after a mortgage is closed before the borrower is willing or able to go to the effort and expense of refinancing or moving. In the case of refinancing, the period can be six or fewer months in a strong rally because some costs, such as the appraisal and title search, can be avoided if they were recently documented for the existing loan. (The declining "hassle" factor has shortened this period as well.) In the case of moving, a much longer period normally elapses. Surveys by the National Association of Realtors, for example, indicate that average tenure in a house ranges from five to seven years.

We say that passthroughs *season* with respect to refinancing and turnover. That is, prepayment rates increase from very low levels during the early months up a short *ramp* in the case of refinancings and a longer *ramp* in the case of seasoning. A fully *seasoned* security is considered to be *off the ramp*. This terminology is applied more generally to turnover. By convention, market participants classify passthrough seasoning as follows:

- *new*, 0 to 30 months;
- *moderately seasoned*, 31 to 60 months;
- *seasoned*, over 60 months.

Seasoning also can indicate *burnout*. Burnout refers to the fact that the more the pool of borrowers is exposed to refinancing incentives, the less they respond to subsequent refinancing incentives. That is, as borrowers whose circumstances permit them to respond to attractive borrowing rates do so, fewer borrowers remain in the pool that are likely to respond to a given level of rates—a phenomenon known as adverse selection. Consequently, refinance-driven prepayment rates begin to slow. Likewise, passthroughs that have been heavily refinanced in past rallies tend to respond more sluggishly to subsequent refinancing opportunities. A better indication of the refinancing *path* experienced by a passthrough is origination year and coupon.

Finally, the *factor* is a good indicator of cumulative refinancing events. The factor is the fraction of original principal that is still outstanding. This is reported on the pool level monthly and calculated on an aggregate basis for coupon and by origination year within coupon by market participants.

Expanded Pool Disclosure

Well into the 1980s, analysis of prepayment risk and relative value focused on the passthrough characteristics that related to refinancing incentive (or affordability restraints on turnover), seasoning, and burnout: WAC, WAM, estimated age, and factor or percent of principal balance still outstanding. However, as the market continued to grow and mature, MBS broker-dealers and investors began to focus on regional differences in prepayment behavior. For example, California loans, dominated by those originated in higher-cost coastal cities, tended to refinance more aggressively in rallies, whereas New York loans tended to refinance sluggishly owing to the 1% (and higher) tax imposed on mortgages. (For similar reasons, Florida and Texas are also important slow-pay states.) At the outset, geographic location was proxied using the address of the original seller/servicer,[14] but by 1990, the agencies were reporting current loan concentrations by the state in which the property was located. Geographic location also can be a factor when economic activity in particular states or regions is significantly above or below national trends (e.g., southern California in the early 1990s).

[14] Clearly this is a weak proxy because consolidation led to increasingly regional and national mortgage banking companies.

Loan size became a valued indicator of prepayment risk in the late 1990s. The market had long understood that to achieve equivalent payment savings, borrowers with smaller loans needed much steeper rate incentives than other borrowers.[15] Many market participants also had observed that lower-priced properties tended to turn over more readily in rising-interest-rate environments because they were more affordable. There are variations in prepayment speeds across varying average loan sizes. Historically, smaller balance loans prepaid more slowly at rally peaks.

In 2003, the agencies agreed to expand disclosure of underlying loan characteristics to include six additional characteristics (reported as weighted averages and quartile distributions and updated monthly):

- loan-to-value (LTV) ratio at origination (OLTV ratio);
- loan purpose: refinancing or purchase;
- servicer (seller name was already disclosed; this captured transfers of servicing);
- credit score (typically FICO);
- property type: one unit of two to four units;
- occupancy: owner-occupied, investment property, second home.

This disclosure was welcomed by the broker-dealer and investor communities. Loan-level analysis on private-issue CMOs and residential ABS had long indicated that these characteristics were very useful in understanding historic and forecasting future credit and prepayment performance. In brief:

- Higher OLTV loans tend to prepay more slowly because they suggest a more leveraged household and because borrowers have lower equity stakes and tend to default more frequently.
- Loan purpose disclosure would have been stronger if it distinguished between a rate refinance (generally improves borrower credit, refinanceability) and a cash-out refinance (generally increases leverage, lowers credit and refinanceability). Rate refis at historic lows in yield may indicate that borrowers are less willing to move as interest rates rise—commonly referred to as the "lock-in effect."
- As originator/servicers have consolidated and become increasingly large national bank and mortgage banking entities, differences in refinancing activity (owing to marketing styles, operational efficiencies, concentrations of various channels of origination, etc.) have been discerned across servicers.
- In general, the more pristine a borrower's credit the more able he or she is to refinance. However, FICO changes monthly as borrowers add or retire new obligations and service existing ones; FICO at origination may not be a good indicator of FICO after origination.
- Single-family units are easier to underwrite; two- to four-family units may refinance more slowly simply because loan evaluation is more complex. Two- to four-family

[15] A more precise measure would be payment savings as a percentage of household income, but this is not available.

units also have, even when owner-occupied, an investment nature, as we discuss next.

- Owner-occupied homes tend to have lower default rates, and borrowers tend to be more sensitive to refinancing opportunities. Investment properties tend to refinance more slowly. Borrowers may be more likely to default on a second home but are likely to be very sensitive to refinancing opportunities.

Anatomy of the Agency Passthrough Market

In general, the "anatomy" of the agency passthrough market is driven by two concerns: liquidity and expected prepayment behavior. Liquidity is maximized in the trading of generic agency passthroughs, and prepayment behavior is parsed in the trading of specified pools and small pooling programs.

Generic Securities

Generic passthrough classes are divided first by agency. GNMA should trade distinctly from GSE passthroughs; the guarantee is backed by the US government, and the underlying loans are assumable, subject to lower loan limits, and possess demonstrably different credit performance.

The market does perceive a difference in credit quality between GNMA and the GSEs and consequently demands a risk premium for the conventional agency passthroughs. All other factors being equal, this would translate into a higher yield for the GSE-guaranteed issues. However, all else is not equal.

Fundamental and technical issues influence the price behavior of the securities and over time have tended to swamp differences in credit quality. At one time, 30-year GNMA also enjoyed a liquidity advantage over the conventional 30-year programs. In the 1970s and 1980s, 30-year GNMA passthroughs were the *de facto* market benchmarks (Ginnie Mae was virtually a synonym for mortgage-backed security), giving way to Fannie Mae by the mid-1990s. However, declining market share (of both new and outstanding passthrough supply) has not consistently hurt its price relationship to FNMA (and by extension, FHLMC). Rather, much of the demand for GNMA passthroughs is entrenched, coming from foreign investors who look more to the guarantee than to the underlying credit quality of the loans or quality of the GSE's reserves funded by guarantee fees) and from Ginnie Mae and "government" mutual funds that have written these securities into their prospectuses. Entrenched demand in the face of sharply shrinking supply now tends to support GNMA prices, so they can be significantly higher than FNMA prices than the difference in payment delay alone would suggest (the 14 days of delay are worth four to eight ticks depending on the interest rate environment; FNMA should trade behind GNMA).

Finally, changes in pooling criteria boosted production of GNMA IIs relative to GNMA Is. This resulted, at times, in new issuance of GNMA Is trailing that of GNMA IIs. Also, differences in pooling criteria have an effect on the prepayment characteristics and hence on the relative value of GNMA IIs to GNMA Is. An exploration of these differences, however, is beyond the scope of this chapter.

Fannie Mae and Freddie Mac guarantees are comparable and the eligible loans are fungible, but they trade differently for a variety of reasons. The difference in delay is worth about four to eight ticks, depending on the level of yields, making Freddie Mac's shorter delay more expensive, a factor that influences demand, all else equal.

Coupon Stacks

Within programs, such as 30-year Gold PC or GNMA I SF, pools are aggregated by coupon. While it is feasible to create agency passthroughs with coupons that vary by as little as one eighth of a percent, concentrating issuance in whole and half coupons simplifies relative-value analysis and trading strategies and maximizes liquidity. Most standard market reports, such as daily price reports or monthly prepayment reports, ignore the small amounts of quarter and eighth coupons outstanding. Market slang refers to the whole and half coupons as the "coupon stack."

Within a generic coupon, pools are grouped by issue year or vintage. The most useful strategy is to define issue year at the loan level rather than by the issue date of the pool. In other words, if a pool is issued January 1, 2015, but the average age of loans at issue indicates the loans were closed in November 2014, the pool is included in the 2014 vintage.

TBA Coupons

In current practice, in the fixed-rate market, TBA securities, or coupons, are the whole and half coupons of the mainstay 30- and 15-year programs, as well as the 10- and 20-year GSE pools. The term TBA means that the actual pools delivered to settle the trade are "to be announced."[16] Actual pool numbers are provided within 48 hours of the delivery date; notification or "allocation" dates are set by the Securities Industry and Financial Markets Association (SIFMA).

[16] Those terms are resolved in the pool notification process, which must take place at least 48 hours before delivery. Cutoff times are set by the SIFMA, along with standard requirements for delivery on settlements of agency passthroughs. The chief of these are numbers of pools and variance between trade amount and the current principal balance of pools delivered. The requirements for TBA trading are spelled out in the *Uniform Practices Manual.*

Unlike other fixed-income securities, including CMOs and other structured products that settle a defined number of days after the trade, TBA passthroughs settle once a month, roughly mid-month.[17] This practice evolved in the early days of agency securitization to accommodate the fact that originators want to sell forward to hedge their pipelines (lock in the prices at which they are originating loans) but cannot predict to a round number the actual principal amount of closed loans going into a pool. (It also follows that pool numbers would not be known.) The practice of trading new pools TBA enlarged quickly to include existing pools, permitting dealers to sell agency passthroughs in response to investor inquiry without owning or having to quickly buy them from another investor or dealer.

However, the WAC and WAM assumed for a TBA coupon are not necessarily the weighted average of WAC and WAM of all GNMA II 5.5s (the generic). Instead, they are the WAC and WAM of the pools most likely (cheapest) to be delivered to settle the trade. Because these assumptions are a matter of judgment and recent settlement experience, they can vary somewhat across broker-dealers. This is an important consideration when analyzing relative value: Measures such as OAS are very sensitive to WAM and somewhat sensitive to WAC (for a given coupon). In some cases, the TBA assumptions can determine whether TBA is a "pick" or "give" in spread to a CMO or another TBA. They also can cause a TBA coupon to look rich in one firm's research and cheap in another's.

Dollar Roll Financing in the TBA Market

TBA trading gave rise to the *dollar roll* as a mechanism for dealers to "borrow" passthroughs they had sold short.[18] In fact, a dollar roll is a contract to buy an amount of TBA passthroughs for a close delivery date and sell the same amount of the same passthroughs back for a more distant delivery date. Similar to a Treasury repo trade, the difference in buy–sell prices (the *drop*) implies a cost-of-carry or financing rate, given a prepayment assumption. (This expected financing rate, then, is subject to prepayment risk.) In general, in quoting the implied financing rate, the market starts with the consensus (mean) of MBS dealer prepayment projections.[19] A generic passthrough is "rolling special" when the implied financing rate is below 1-month LIBOR or some other relevant financing rate. It is common for a range of 30-year passthroughs to roll well. Less commonly, the roll may heat up in select 15-year coupons.

[17] Roughly 99.9% of TBA trading volume settles in the defined notification and delivery process. Communication and other technological advances today permit "TBA" trades to be settled for cash or any $T + n$ delivery desired. However, these trades are rare. TBA trades also may have "stipulations," such as pools per million, WAM, or WALA range. Typically, a small markup is charged for "stips." Specified trades, in which the pool numbers are actually known, may trade for any delivery date as well.

[18] A more detailed discussion of dollar rolls is provided in Chapter 33.

[19] Typically as quoted on Bloomberg.

The dollar roll is a critical component of passthrough trading strategies and a vital cause and effect of demand (a hot roll feeds on itself). In general, the stronger the demand for a particular coupon from a particular agency (or sometimes, the tighter the supply), the more likely dealers will be short and have to resort to dollar roll transactions to settle trades. Demand for the roll drives the implied financing rate down. From their side, investors may use the roll either as a source of financing for TBA trades (so another characteristic of TBA trading is that it can be self-financing), or they may roll securities, taking the financing rate as a "yield sweetener" on their passthrough portfolio. Many of these "sellers of the roll" invest the drop in higher-yielding money market and other short-term securities to further boost yields. (They may keep the roll on for months at a time.) For this reason, how well a passthrough is rolling is an important determinant of its relative value either within a "coupon stack" or across agency passthroughs of the same term and coupon. Likewise, how well a coupon is rolling is an important determinant of demand for it.

Specified/Customized Trades

Specified or customized trades are trades in which the pool number and original face (principal amount outstanding is a function of prepayments and is not known until the next factor date) are known at the time of the trade.[20] In practice, the candidates for specified trades are pools with prepayment stories that should command a premium over the TBA price for that program and coupon. Until the late 1990s, prepayment stories within the mainstay 15- and 30-year programs were largely limited to seasoned paper (originally indicated by WAM, so this was called WAM paper) and geographic concentrations. Also, off-the-run programs backed by buydown loans, relocation loans, prepayment penalty loans, and so forth can offer favorable theoretical and experienced prepayment profiles. Finally, pools with statistically low WACs for the particular coupon class (GSE and GNMA I only) could trade as less callable.

In the late 1990s, low original loan size came into vogue with investors seeking less callable loans. Going a step beyond average loan size, originators began to segregate loans with balances below a specified limit in pools, warrant their characteristics, and market them in specified trades. This practice broadened to include other characteristics, such as LTV ratio, credit score, property type, and occupancy. The actual trading of these pools helped to spur the agencies to expand disclosure to include OLTV ratio, loan purpose, servicer, credit score, property type, and occupancy. Relative-value analysis of these pools is discussed in Chapter 35. Theoretically, offerings of a wide smorgasbord of specified pools should alter the prepayment sensitivity of TBA securities. That is, by removing those loans that are thought to possess "better convexity," the remaining universe is allocated to the cheaper-to-deliver TBA pools which are more negatively convex.

[20] Chapter 8 provides a more detailed discussion of customized trades.

Key Points

- Agency passthrough securities are issued by Ginnie Mae (GNMA), Fannie Mae (FNMA), and Freddie Mac (FHLMC). Of these, only GNMA carries the full faith and credit of the US government. Both FNMA and FHLMC are believed to carry an implicit government guarantee.
- Pools are issued under various pool prefixes to identify the type of mortgage loan underlying the passthrough. For example, FNMA securitizes 30- and 15-year loans under the CL and CI pool prefixes.
- Cash flow projections based on average pool statistics represent estimated cash flow because loan amortization is nonlinear and a range, albeit narrow, of note rates and loan ages are often represented within a pool.
- Yield sensitivity increases as a passthrough price moves away from par. Discount passthrough yield increases with prepayment rates. Conversely, premium passthrough yield increases as prepayments slow.
- The PSA ramp was created to account for the fact that mortgage prepayment rates tend to follow a seasoning ramp beginning at 0.2 CPR in the first month and increasing by 0.2 CPR per month, reaching a peak of 6.0 CPR in month 30.
- The PSA ramp is used to compare relative value of newly originated loans and price CMOs.
- PSA speeds are quoted as a percentage of the PSA assumption.
- Prepayment rates may be decomposed between turnover, refinance, curtailment (partial prepayment), and default.
- The default rate between GNMA and conventional loans may be substantial owing to the weaker underwriting standards of Ginnie Mae vis-à-vis either Fannie Mae or Freddie Mac.
- Beginning in 2003, the GSE expanded pool disclosure to include quartile data of credit score, original loan-to-value ratio, loan purpose.
- All three agencies release loan-level transaction data. Of the three, FHLMC and GNMA offer complete coverage, whereas FNMA reports loan-level data on pools issued on or after December 2013.
- The dollar roll is the primary financing mechanism in the agency MBS market. The dollar roll allows originators to sell their production forward, thus locking in prices; dealers can either go long or short collateral, and investors are able to use the roll market to enhance portfolio returns.
- Specified trades are trades in which the pool and factor are known.
- A specified pool is one whose prepayment profile is known to be superior to that of generic or TBA pools.

CHAPTER 7

HYBRID ARMs

BILL BERLINER, ANAND BHATTACHARYA,
AND STEVE BANERJEE

After reading this chapter you will understand:

- the attributes and features of hybrid ARMs;
- factors that influenced the growth of hybrid ARM issuance;
- the prepayment behavior of hybrid ARMs;
- differences in how fixed-rate and ARM pools are created;
- different ways of evaluating and quoting hybrid ARM pools.

Fixed-period or "hybrid" adjustable-rate mortgages are a category of mortgage products that combines characteristics of both traditional fixed- and adjustable-rate loans. Although the product has been around since at least the 1990s, the sector first became a popular option for borrowers in 2003 and 2004. Since that time, hybrid adjustable-rate mortgages (ARMs) have been the most widely originated and utilized adjustable-rate loans originated by mortgage lenders. While a variety of products and features are available, hybrid ARMs share a number of common attributes that differentiate them from other mortgage products.

The rapid growth in hybrid ARM issuance in the last decade reflected the converging interests of borrowers and investors. While borrowers were attracted by the relatively low prevailing rates for hybrid ARMs, investors (primarily banks and depositories) found that hybrids offered a fairly liquid short-duration investment vehicle that often carried higher yields than other options, such as short-amortization fixed-rate mortgage-backed securities—loans with 10- and 15-year amortization periods—short-duration structured MBS, or agency debentures. While total ARM issuance as a share of overall production has declined in the aftermath of the financial crisis, hybrid products continue to represent the bulk of ARM issuance.

Hybrid ARM Products

ARMs are characterized by a number of features. The note rates on the loans are recalculated at regular intervals by adding a spread or "margin" to a benchmark index such as one-year Constant Maturity Treasury (CMT) or 12-month London Interbank Offered Rate (LIBOR). The loans' note rates are subject to caps that limit how much the loan's rate can change when the note rate is recalculated (or the rate "resets") along with a maximum interest rate over the life of the loan.

The most common ARM product prior to 2003 was the annual reset or 1/1 ARM. These loans' initial note rates were effective for the first year; after 12 months, and every 12 months thereafter, the loans reset based on the current level of the benchmark index.[1] Hybrid ARMs share many of the features of annual ARMs, except that the period for which the teaser rate is effective is longer than one year. (The "hybrid" moniker became widely used because of the products' combination of fixed- and adjustable-rate features.) Standard hybrid products include loans with initial fixed-rate periods lasting three, five, seven, and ten years. At the end of the fixed-rate period, the loans begin to reset annually (or, for a small number of loans, semiannually) in the same fashion as the traditional annual reset ARM. Since hybrids normally convert to annual ARMs after the teaser period, the standard nomenclature is to refer to the products as 3/1s, 5/1s, and so on.

The longer period for which the teaser rate is effective necessitates an additional cap that specifies how much a loan's rate can change at the first reset. As a result, hybrid ARM products always specify three caps: the cap on the initial rate change, the periodic cap, and the loan's life cap. Market convention is to quote cap structures in that order. For example, a 5-2-5 cap structure on a loan with a 3% initial rate means that the loan's rate cannot change at the first reset by more than 5%; the rate cannot change on any subsequent reset by more than 2%; and the note rate can never be greater than 8%. (Note that caps specify how much the rate can change in either direction, i.e., how much the rate can increase or drop at each of these points in time.) Generally, shorter hybrids have lower initial caps; a common cap structure for 3/1s is 2-2-5 (i.e., initial and annual reset caps of 2% with a maximum change in a loan's rate of 5%). Longer-reset hybrids typically have higher initial caps, with a 5-2-5 cap structure commonly seen in 7/1 and 10/1 loans. Conforming 5/1 ARMs have been issued with either 2-2-5 or 5-2-5 cap structures, although the more borrower-friendly 2-2-5 structure is increasingly common. (Freddie Mac, in fact, stopped buying and securitizing loans with a 5-2-5 cap structure in 2014.)

While the bulk of hybrid issuance has been prime-quality loans, it was common for subprime and "alt-A" loans to be structured as hybrid ARMs prior to 2008. In fact, the majority of subprime loans issued in the early and mid-2000s were 2- or 3-year

[1] The initial rate was frequently called a "teaser rate," since it was set at a relatively low rate in order to entice borrowers to utilize the product. The term is still used interchangeably with the "start" and "initial" rate for hybrid ARMs.

fixed-period ARMs.[2] Hybrids also often were originated with interest-only (IO) amortization features, for which the interest-only period might terminate on either the first reset date or some time afterward. For example, it was common to see 5/1 IO ARMs offered with either five- or ten-year interest-only periods; the latter spread out the potential payment shock experienced by the borrower over two periods rather than at a single point in time. While lenders continue to offer IO hybrids on a limited basis, the hybrid ARMs issued at this writing are overwhelmingly fully amortizing 30-year loans.

The underwriting of all ARMs has changed notably since the financial crisis of 2007–8. Prior to that point, lenders had broad discretion with respect to the assumptions for post-reset rates and payments used to calculate qualifying ratios. As a result, many lenders qualified borrowers using the lower of the teaser rate or the fully indexed rate. The combination of relatively high benchmark rates, the national decline in home prices that deprived borrowers of their equity, and the prevalence of interest-only products led to inordinately high levels of delinquencies and defaults on hybrid ARMs. The Dodd-Frank Act, with its introduction of "ability to repay" standards, mandated that borrowers be qualified at the *higher* of either the fully indexed or introductory rate in order to be classified as "qualified mortgages" under the Act.[3]

Borrower and Investor Clienteles

Historically, mortgagees in the United States have been reluctant to utilize adjustable-rate mortgages to finance their home purchases. Unlike borrowers in England and other developed countries, Americans have a noted preference for the stability of fixed-rate loans and are traditionally disinclined to accept the risk of payment increases, even if the product offers a substantially lower initial note rate. This was clearly reflected in the relatively small share of borrowers that took out adjustable-rate mortgages prior to mid-2003. The exception was during periods of high fixed interest rates when the percentage of ARM applications spiked. This occurred during both 1994 and 2000, when fixed mortgage rates rose to very high levels. In addition, a large number of borrowers utilizing ARMs prior to 2003 were first-time homebuyers and younger borrowers that accepted the incremental rate risks in exchange for a lower initial rate and payment, allowing these borrowers to qualify for the loans.

Hybrid ARM issuance first surged in the second half of 2003, after a mid-summer spike in mortgage rates cooled off what had been a booming refinancing market. Attempting to maintain origination volumes, lenders aggressively marketed the product

[2] In the subprime market, the terminology was somewhat different; these loans were known as 2/28 and 3/27 ARMs because they often reset every six months rather than annually.

[3] The "qualified mortgage" classification offers lenders protection against liability if such loans originated by the lender eventually go into default.

to mortgagees who had not yet refinanced, noting that the fixed period and caps associated with hybrid ARMs mitigated the product's reset risks. The acceptance of the product by consumers resulted in hybrid ARM issuance that outstripped that of the more traditional 1/1 ARM after mid-2003. In addition to pushing the overall share of ARM issuance (by loan count) consistently above 30% until mid-2007, it also effectively decoupled ARM market share from the level of mortgage rates.

As an investment product, hybrid ARMs found favor among depositories and other short-duration investors whose MBS investment choices had been limited to short average-life collateralized mortgage obligations and 15-year mortgage passthrough securities. They also found some sponsorship among money managers and total-return investors, especially after Lehman Brothers announced that it would add hybrid ARMs to their MBS market index in the fall of 2006.

Prepayment Behavior of Hybrid ARMs

While a detailed examination of hybrid ARM prepayment behavior is beyond the scope of this chapter, a few important generalizations can be made that impact the valuation and trading of the product. As is generally the case with adjustable-rate loans, baseline hybrid ARM prepayment speeds are typically faster than those of fixed-rate loans, all else equal. In part, this is due to their larger loan sizes; for a variety of reasons, the average sizes of ARM loans are significantly larger than fixed-rate loans. Since 2000, for example, the MBA's application surveys have reported that ARM loans have been an average of more than $200,000 larger than fixed-rate loans. Borrowers utilizing hybrid ARMs are also believed to be more sophisticated and aggressive in exploiting perceived refinancing opportunities than fixed-rate borrowers. As a result, baseline hybrid speeds are typically faster than those of fixed-rate loans with comparable refinancing incentives.

Hybrid ARM prepayments also are impacted by the evolving nature of the loans as they age. In particular, their prepayment speeds spike to extremely high levels around the first reset date of the loans. This behavior is generally attributed to the previously noted reluctance of American homeowners to utilize mortgage loans with adjustable note rates; many borrowers look to refinance out of their loans as they exit their teaser period and the loans actually become "adjustable." Depending on available rates for different products, borrowers may refinance into either a fixed-rate loan or a new hybrid ARM that has a fixed rate for an extended period, effectively "resetting the clock" at a lower rate. Hybrid prepayment speeds also experience smaller but perceptible spikes around subsequent reset dates. This phenomenon is quite similar to the annual upticks in speeds for 1/1 ARMs, and is generally attributed to the impact of a pending rate reset on borrower behavior; the prospect of a rate change ostensibly causes many borrowers to reassess their financing options.

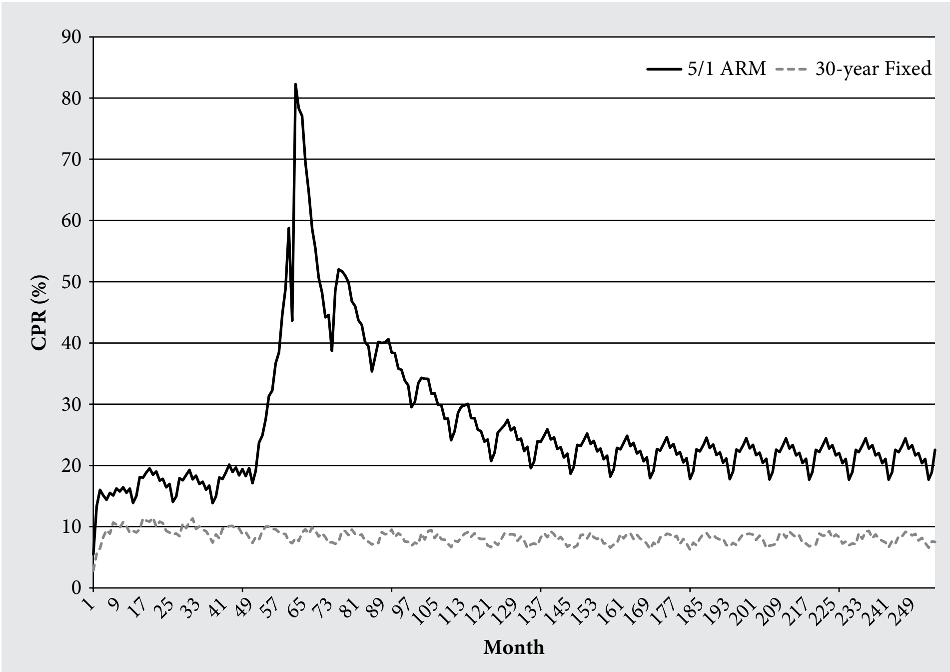

FIGURE 7.1 Projected CPRs for newly issued 5/1 hybrid ARM and 30-year fixed-rate MBS

Source: Quantitative Risk Management, Inc.

As a result, hybrid ARM prepayment speeds exhibit patterns and sensitivities that are different from those of fixed-rate MBS. Figure 7.1 contains projected one-month CPRs over time for newly issued 5/1 hybrid ARMs and 30-year fixed-rate MBS from Quantitative Mortgage Research's model. In addition to the ARM's significantly faster initial speeds, the figure clearly shows the sharp spike in prepayment speeds around month 60 that typically occurs around the time of the first reset, with annualized speeds in excess of 70%. It also illustrates the pickup in speeds that corresponds to annual resets of the pool's underlying loans after the initial reset.

Another variable influencing hybrid prepayment speeds is the level of the loans' benchmark index. ARM loans resetting during periods of near-zero funding rates (which prevailed from late 2009 until at least early 2015) will have prevailing note rates that are well below those available for either newly issued fixed-rate or hybrid ARM loans. At this writing, for example, 12-month LIBOR is hovering around 0.50%; post-reset LIBOR ARMs that have a standard 225 basis point margin therefore have note rates in the area of 2.75%, while both 30-year fixed-rate and new-issue 5/1 mortgages have published rates between 3.25% and 4%. The low note rates on resetting (or "fully indexed") hybrid ARMs serve as a refinancing disincentive and act to dampen the refinancing activity traditionally seen on seasoned hybrid loans.

Securitized ARM Markets

A major difference between the fixed- and adjustable-rate passthrough markets is that ARMs do not trade in a to-be-announced (TBA) market (i.e., a market for standardized forward commitments). This difference, which persists despite a number of attempts to develop a hybrid ARM TBA market, has resulted in different pooling practices for the two product groups. In all but a very limited number of cases, fixed-rate pools are created by aggregating loans into pools carrying a designated coupon rate. The coupons that can be traded as TBAs are specified in 50 basis point increments (i.e., 3.5s, 4.0s, etc.). The minimum 25 basis point spread between any loan's note rate and the pool coupon reflects the "required" or "base" servicing strip which must be held against the loan. Subject to constraints that include the base servicing, lenders can create different coupons based on their calculation of what delivery constitutes "best execution" for their loans. To pool a loan into a higher coupon, lenders may monetize or "buy down" the guaranty fee (g-fee) charged by the agency for credit support; conversely, loans can be pooled into lower coupons by either selling some or all of the remaining or "excess" servicing (i.e., the interest remaining after the base servicing, g-fees, and pool coupon are allocated) or holding the excess servicing on the lender's balance sheet. Most importantly, the note rates of all loans in a fixed-rate pool are always higher than the pool's coupon by a minimum of 25 basis points.

Hybrid ARM pooling practices are consistent with those used for all ARM products which, because of the lack of a standardized forward market, have evolved along different lines. While hybrid pools must contain only one product type (e.g., 3/1s or 5/1s), there is no targeted pool coupon; rather, the coupon is simply the weighted average of the net note rates (i.e., the note rates less the required servicing and guaranty fees) of all loans in the pool. (The government-sponsored enterprises do not offer g-fee buydowns or buy-ups for ARM products, and lenders typically do not hold ARM excess servicing.) These practices mean that loans with net note rates both higher and lower than the coupon rate can be pooled together, subject to limits for how much the highest and lowest note rates in the pool can differ from the weighted average coupon rate. As a result, ARM pool coupons are typically quoted to three decimal points. In addition, their coupon rates change over time as loans in the pool pay down at different rates. (While sometimes seen in private-label deals backed by fixed-rate loans, so-called weighted-average coupons are much more common in the securitized ARM markets.) A pool's margin over the benchmark index after accounting for servicing and g-fees (i.e., the "net margin") is also a weighted-average calculation of the pool's remaining loans, and also typically changes over time.

The lack of a standardized TBA market means that agency ARM products generally trade as specified pools and, as a result, are less liquid than current-coupon fixed-rate MBS, resulting in higher trading and hedging costs. It is also more difficult to hedge a portfolio of ARM loans since there are no TBAs into which newly created pools can be delivered. As a result, traders must hedge ARMs with products, such as 15-year passthroughs or Eurodollar futures, whose price changes are not directly correlated to those of the asset being hedged. Higher financing costs also result from the lack of the cheap and convenient financing offered through dollar rolls in the fixed-rate TBA markets. Hybrid ARM pooling practices do, however, offer additional flexibility with respect to pooling high-balance or "super-conforming" loans, i.e., loans with balances that are between $417,000 and $625,500 originated in high-cost areas. While fixed-rate pooling standards allow only 10% of any TBA-eligible pool's balance to be comprised of super-conforming loans (through the "*de minimis* exemption"), ARM pools are not subject to this constraint; virtually all loans in an agency ARM pool may have super-conforming balances.

There are a few additional wrinkles to pooling through the Ginnie Mae ARM program. Most Ginnie Mae hybrid pools are created as multi-issuer securities within the Ginnie Mae II program, which means that there are pools issued by the agency each month for different hybrid products. Under the various applicable programs, all loans in a pool must reset in the same month, and the pool resets the first month after the calendar quarter in which the underlying loans reset. For example, a pool backed by 5/1 loans issued in February 2015 (i.e., the February pool) will have an annual reset starting in April 2020, as will the March pool; the April pool, however, will first reset in July 2020.

Securitized ARM Trading and Analysis

Hybrid ARMs are traded as a "spread" product, with a number of different pricing and valuation conventions. At this writing, new-production hybrids are quoted to a spread over the zero-coupon Treasury curve (the "Z-curve") at a prepayment speed of "15% CPB." This convention assumes a constant speed of 15% conditional prepayment rate (CPR) until the pool's weighted average reset date, at which time it is assumed to prepay completely or "balloon." CPB is the preferred prepayment convention for analyzing newly issued MBS with adjustable-rate collateral. Utilizing Z-curves is more sophisticated than simply pricing at a spread over the interpolated yield curve (i.e., at a point on the on-the-run Treasury or swap curve that matches the security's weighted average life). By using a spread over the Z-curve, every monthly cash flow is discounted at the rate effective for its particular point in time, as opposed to discounting all cash flows at a single constant yield.

The Z-spread trading convention is, however, problematic for a number of reasons. From a practical standpoint, the zero-coupon curve is impossible to replicate for a particular point in time after the fact. Combined with the absence of TBA screen prices, it is almost impossible to reconstruct accurate time series of prices for analysis, and it is also difficult to retroactively price bonds and reconstruct trading activity. The 15% CPB assumption is also quite simplistic in that it simply excludes the value of the ARM's adjustable-rate "tail" (i.e., the cash flows after the pool undergoes its first reset), which

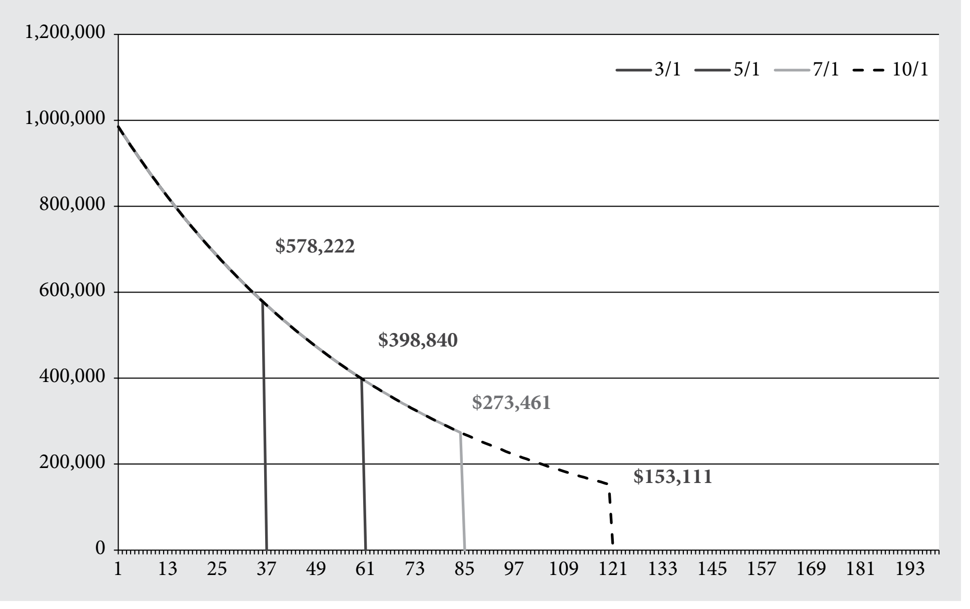

FIGURE 7.2 Unpaid principal balances on $1mm hybrid ARM pools run at 15% CPB

often comprises a significant share of a pool's value. The value of a pool's tail is influenced by a number of factors, most notably the length of the teaser period. As illustrated in Figure 7.2, the unpaid balance at the first reset on a $1 million pool run at 15% CPB is dependent on the length of the assumed teaser period. All things equal, the convention of ballooning at the reset ignores more of the tail's economic value for shorter reset hybrids than for those with longer resets, where the future remaining tail balance will be smaller and received at a later point in time.

The "hybrid" nature of the product also means that the investment attributes of hybrid ARM securities evolve over time. As a proportion of the remaining balance and value of a hybrid pool, both the UPB and value of the tail increase as the pool ages. This means that ignoring the tail value, as the CPB convention does, increasingly distorts a pool's value as it ages and approaches its first reset date. In order to obtain more accurate valuations, seasoned hybrids (as well as pools that have passed their first reset dates and are effectively 1/1 ARMs) are valued using conventions commonly utilized for more traditional floating- and adjustable-rate instruments. Investors will typically run the bonds using either a constant CPR or prepayment vector and measure the spread over the benchmark index using either a discount margin (DM) or bond-equivalent effective margin (BEEM). Both metrics take the security's calculated yield at a price and speed and subtract the level of the index, giving the investor a sense of how much spread the instrument offers over the reference rate.[4] (It is also common to measure a pool's

[4] Discount margin is calculated using the security's monthly mortgage yield, while BEEMs use the (somewhat higher) semiannual bond-equivalent yield to calculate the spread.

"effective spreads" over the index's forward curve.) There is, however, no standard protocol for determining the point in time when investors should switch valuation methods from a Z-spread to an effective margin. As a result, valuations for moderately seasoned hybrid pools can often vary substantially for different dealers and investors, as they may be using very different methodologies to evaluate the pools.

As with other fixed-income products, sophisticated investors will utilize more complex valuation methodologies. Option-adjusted spreads, for example, take into account not only the value of cash flows adjusted for the expected costs associated with prepayments, but also account for the (negative) values of the underlying loans' various rate caps. Depending on both the configuration of the forward yield curves and the level of volatility, cap structures can have a meaningful impact on the relative value of hybrid ARMs as compared to both other ARM pools and alternative products and sectors.

Key Points

- Adjustable-rate mortgages have been available to borrowers in the United States for many years. Hybrid ARMs, which have characteristics of both fixed- and adjustable-rate mortgage loans, first became popular around 2003–4 as they met the needs and desires of both borrowers and investors. Investors utilized the product as an alternative to other short-duration securities, while borrowers in the United States liked receiving rates below fixed-rate offerings that nonetheless offered some stability in their mortgage rates.
- Hybrid ARMs are similar to traditional annual ARMs in that they reset periodically, based on a spread or margin over a quoted index. They differ in that the initial fixed-rate period of the loans is longer than a year, but then effectively convert into loans with rates that reset annually (or occasionally semiannually). Common fixed-rate periods are three, five, seven, and ten years.
- Standard hybrid ARM product metrics include the initial teaser rate, the length of the period that the teaser rate remains effective, the reference index, the margin, and the rate caps. Virtually all loans have initial caps (that limit how much the rate can change at the first reset), period caps (that govern how much the rate can change at each subsequent reset), and the life cap that specifies the maximum allowable change in a loan's rate over its life.
- As experienced with other ARM products, hybrid ARM prepayment speeds are significantly faster than those observed for most 30-year fixed-rate products. In addition, hybrid ARM prepayment patterns typically reflect borrowers' aversion to short-reset adjustable rate mortgage products. Prepayments are relatively stable until the product approaches its first reset, at which time prepayment speeds spike briefly to extremely fast levels.
- There are a number of differences in the production and trading of hybrid ARMs as compared to fixed-rate pools. As there are no TBA markets for ARMs (as of this writing), hybrid ARM pools trade almost exclusively as specified pools. In addition, the government-sponsored enterprises do not quote buy-up and buydown multiples as they do for fixed-rate loans, necessitating different pooling practices.
- Issuers do not target even-increment coupons as they do when creating fixed-rate pools; rather, the pool coupon falls out as a weighted average of all the loans' note rates after the guaranty fees and required servicing are removed. As a result, some loans in a pool may

have note rates below the pool's coupon rate; moreover, the pools coupon rate typically changes as loans in the pool amortize and prepay.

- Newly issued hybrid ARM pools are traded to a spread over the zero-coupon Treasury curve using a unique prepayment convention that assumes a constant 15% CPR until the first reset date, at which time the pool is assumed to "balloon" (i.e., prepay in its entirety). This is referenced as 15% CPB, and assumes that the security has no value after the loans reset for the first time. This methodology becomes increasingly inaccurate as the pool ages and approaches the first reset, as the adjustable-rate cash flows comprise an increasingly large share of the pool's economic value. To account for this transition, at some point after issuance traders begin to value and quote pools based on the spread of the pool's yield over its benchmark index at a constant CPR over its remaining term.
- Sophisticated investors value hybrid ARMs using modeling techniques such as option-adjusted spreads that can value both the projected cash flows and embedded rate caps.

CHAPTER 8

CUSTOMIZED MORTGAGE-BACKED SECURITIES

ANAND BHATTACHARYA, BILL BERLINER, AND STEVE BANERJEE

After reading this chapter, you will understand:

- the reasons for the creation of custom MBS;
- the projected prepayment pattern of the underlying loans in custom pools;
- the various parameters that are used to create custom MBS;
- the pricing of custom MBS versus generic MBS or to-be-announced (TBA) market;
- the determinants of pay-up or discounts to TBA prices;
- the methodologies used for the relative value assessment of custom MBS;
- the challenges and issues in the valuation of custom MBS.

Over the years, the mortgage-backed securities (MBS) market has realized that various obligor and property attributes inherent in mortgage loans lead to predictable and observable differences in MBS performance and associated performance measures such as duration and convexity. As such, a corollary of this development has been the growth of a sector of the MBS market, generally described as the "customized MBS" sector. The most significant manifestation of this growth has been in the conventional fixed-rate MBS market. Depending upon the characteristics of the underlying loans, such securities are typically priced at a premium or pay-up to the generic MBS or to-be-announced (TBA) market. Originators seek to maximize proceeds from the sale of loans by pooling loans with desirable performance attributes to create such securities. Investors are attracted to customized MBS due to the positive performance characteristics resulting from the attributes of the pooled loans. In recent years, due to specific pooling criteria used by the GSEs, such as the separate pooling of high loan-to-value loans, certain customized MBS have also been created as a byproduct of pooling policies. The purpose of this chapter is to discuss descriptive and valuation issues in the customized MBS markets.

Conceptual Underpinnings of Custom MBS

In the MBS market the pricing benchmark is the TBA market. The underlying characteristics of the loans comprising the MBS that are traded in these markets are fairly broad as long as such loans conform to the pooling guidelines established by the insuring GSE or agency (in the case of Ginnie Maes). As such, the valuation of these securities with respect to prepayments and derivative valuation metrics, such as duration and convexity, is based upon the analysis of the entire cohort of loans in a particular coupon class. However, based upon the composition of a particular pool, the actual prepayment pattern of the pool may be different than the generic cohort. Such differences stem from certain obligor and property characteristics that dampen or accelerate the projected prepayment pattern of such loans, leading to variation in performance relative to the TBA benchmark. The earliest manifestation of the recognition of this concept was the growth of specified pool trading in the early 1980s, which led to systematic valuation differences in pools based upon attributes of the underlying loans. These efforts were essentially centered on exploiting the concepts of geographical location and burnout to identify fast-paying discounts, slow-paying premiums, and less volatile "short WAM" MBS. With the passage of time, this focus on specified pools essentially developed into identifying the characteristics of pools exhibiting superior convexity.

Historically, there are several developments that led to additional growth and institutionalization of the custom MBS markets. Over the years, with the increased availability of additional data on the underlying pools, the development of prepayment models increasingly focused on using loan-level characteristics of pools as determinants of prepayment performance. At the same time, MBS investors realized that loans with superior convexity characteristics outperformed MBS benchmarks, particularly during refinancing waves. As such, this recognition justified any premiums paid for such pools and increasingly legitimized the existence of the custom MBS market, as investors recognized the potential return benefit from exploiting differences in prepayment behavior. At the same time, originators were provided with a source of demand that allowed them to create pools with superior convexity profiles, with most large originators developing loan disposition strategies incorporating these attributes for the creation of custom MBS with a view toward maximizing sale proceeds.

Categories of Custom MBS

As noted above, the concept of custom MBS is based upon identifying obligor and property attributes that result in superior performance. Traditional factors such as the age of loans, gross weighted average coupon (WAC), and geographic location continue to be attributes scrutinized by investors seeking incremental value. Custom MBS have also been

Table 8.1 Custom MBS categories

Age	Newly Originated (One-WALA) Various Origination Years Highly Seasoned		
Gross WAC	Low Gross WAC		
WAM	Short Final Maturities		
Geography	New York and Florida Pools		
Loan Size	30-Year MBS	Low Balance Medium Balance High Balance	\$85,000 Original Balance \$110,000 Original Balance \$150,000 Original Balance
	15-Year MBS	Low Balance Medium Balance High Balance	\$75,000 Original Balance \$110,000 Original Balance \$130,000 Original Balance
LTV	High LTV	100–105 LTV 105–125 LTV Greater than 125	
		FNMA CQ; CR; CV and CW Pool Prefixes	
		FHLMC U4 through U9 Pool Prefixes	
FICO	Low FICO	FICO less than 700	

created based on attributes such as loan size, occupancy status, credit quality characteristics (such as FICO score), and loan-to-value ratios. The effect on prepayments of a combination of these factors results in a multiplicative effect of the convexity characteristics of the subject MBS. Customized pools have been used as collateral for structured MBS transactions, with pricing on certain tranches such as interest-only (IO) securities predicated on the advantageous prepayment behavior of the loans. The following sections will discuss the various loan attributes that are used in the stratification process to create various custom MBS. A summary of the different types of custom MBS is described in Table 8.1.

WAC, WAM, and WALA

As discussed previously, the earliest manifestation of custom MBS was specified pool trading, where factors such as gross WAC, age, and geographic location were used as stratification parameters. With respect to gross WAC, the standard definition for low gross WAC pools is loans with note rates that are 25 basis points above the passthrough coupon rate, reflecting the minimum amount of servicing that must be held for each loan. For instance, a low gross WAC FNMA 4% MBS would be comprised of 4.25% loan rate mortgages. In contrast, the gross WAC associated with an average pool is 40 to 50 basis points above the passthrough rate. As such, low gross WAC pools would have dampened refinancing incentives, resulting in slower prepayments and superior convexity.

Loan age has long been recognized as having a significant impact on prepayment speeds. For premiums, new loans trade at pay-ups to TBA due to the tendency of such loans to prepay more slowly in the initial months after origination as the loans move up the seasoning ramp. The extreme case of this category is "One-WALA" loans, which refer to the short weighted average loan age (WALA) of newly originated loans. Other categories of various levels of seasoning are also traded in this sector of the market. At times, depending upon the age of the conventional loans, the relative value assessment of such customized MBS may also include comparisons to 10- and 20-year MBS, some with custom pool type attributes, such as low balances and high loan-to-value ratios (LTVs). At the other extreme, well-seasoned premiums can at times attract a pay-up due to the phenomenon of "prepayment burnout," in which aged high-coupon loans prepay slower than more recently originated loans. Higher coupons may be characterized by prepayment burnout due to the fact that after a prolonged period of fast prepayments, the remaining borrowers in the pool may be less creditworthy or less sophisticated and may not be able to refinance. Alternatively, the property may have suffered declines in value and may serve as a barrier to refinancing. However, the benefits of prepayment burnout tend to disappear when interest rates are very low and a refinancing wave is peaking. In addition, real estate appreciation may negate prepayment burnout effects for premiums. In discounts, seasoning invariably commands a pay-up. Older discounts tend to generate faster-than-average prepayment speeds, partially due to the fact that such loans are farther along the prepayment seasoning ramp. Also, properties underlying seasoned loans are more likely to have experienced significant home price appreciation, which leads to a higher magnitude of cash-out refinancing. In addition to the prepayment effects, seasoned discounts may also command an additional premium due to the pool's shorter average life and final maturity.

Geography

As noted above, the geographic location of a property can also affect the costs of refinancing the underlying loan and thereby impact the actual decision to refinance. To the extent that idiosyncratic geographic factors negatively affect the refinancing decision, the prepayment responsiveness of such loans is likely to be muted, resulting in improved convexity characteristics. In certain states such as New York and Florida, the transaction costs of refinancing are significantly higher than national averages, as both these states levy taxes on refinancing transactions that are not levied elsewhere. In New York, a "Mortgage Recording Tax" is assessed at 0.50% to 1.75% of the loan amount on the borrower, and 0.25% on the lender. In Florida, the costs of refinancing are higher due to the assessment of documentation stamp and intangible taxes at a rate of 0.55% of the loan amount. As such, the refinancing threshold upon a reduction in interest rates is higher in these states, resulting in dampened prepayment speeds. Additionally, expenses such as title insurance and legal fees can be higher than average in some regions, making the economics of refinancing less attractive. Regional differences in housing markets, particularly the rate of real estate appreciation, can also exert powerful influences on prepayment behavior. Rising home prices reduce the underlying property's LTV, resulting in greater refinancing opportunities while also facilitating home sales activity. As such, higher and faster home price appreciation leads to faster prepayment speeds for both premiums and discounts. On the other hand, a sluggish housing market tends to be associated with slower speeds, with less refinancing of premiums, and muted housing turnover for discounts.

Low-Balance MBS

With respect to other loan attributes, the inclusion of loan size as a stratification parameter has manifested in the creation of "low-balance" MBS. Due to the fact that the refinancing process involves certain upfront fixed costs, lower-balance loans require a more than proportionate decrease in the borrower's interest rate to make the refinance process economically justifiable. The borrower incurs significant upfront transaction costs in return for a benefit over time from paying a lower interest rate on the new loan. Refinancing entails certain costs that are fixed irrespective of the size of the loan, including home appraisal fees and some processing costs. However, the savings from refinancing into a lower-rate loan are a direct function of the size of the loan. Therefore, due to the proportionately higher fixed costs, refinancing is less compelling for smaller loans, resulting in slower prepayment speeds. In addition, there is also the widely held belief, perhaps misguided and inflammatory, that borrowers of smaller loans may be less financially sophisticated than large loan borrowers, and consequently may be less likely or less able to take advantage of refinancing opportunities. In any case, premium low-balance MBS command a premium over TBAs, with the size of the premium expanding with higher coupons. Additional expansions of the pay-ups are also likely to occur during periods of high refinancing due to increased demand for improved MBS convexity.

With respect to loan size, stipulations of $85,000, $110,000, and $150,000 maximum original balance are an informal set of standards that have been adopted over the years for conventional 30-year MBS. In the case of 15-year MBS, where loans tend to be smaller in size, the market standard limits are $75,000, $110,000, and $130,000, respectively. These stipulations are referred to as "low-balance," "medium-balance," and "high-balance," respectively in the specific maturity category. (There is some activity for pools with $175,000 maximum balances, which are referenced as "super high-balance" pools.) In the customized loan balance classification, the low-balance category of $85,000 was the first actively traded loan size category. This limit came about as a result of research that indicated a clear difference in prepayment behavior for loans of such sizes. In contrast, the $110,000 and $150,000 limits were conceived during the refinancing waves that occurred between 2002 and 2004, partially in reaction to higher loan sizes caused by real estate appreciation and the fact that many lower-balance loans were being pooled as CRA pools. Lower-balance pools that meet Community Reinvestment Act (CRA) criteria may be pooled as CRA pools rather than low-balance MBS for investment by financial institutions due to the typically higher and relatively consistent pay-ups associated with the CRA category.[1]

It is important to note that the definition of "low-balance" reflects loans' original balance and not current balance. This is to distinguish "true" low-balance pools from higher-balance pools where due to prepayments and curtailments, the current balance may be lower. However, such higher original balance pools with a lower current balance are likely not to exhibit dampened prepayment behavior. It is also interesting to note that the stipulation applies to a pool's *maximum* loan size rather than average loan size due to the fact that pool averages may not necessarily include all "true" low-balance loans, and the dispersion of balances makes the prepayment benefits much less consistent.

Loan-to-Value Ratios (LTVs)

The loan-to-value (LTV) ratio of a loan is a proxy for the equity of the property owner. A higher LTV (lower LTV) implies less (more) equity and results in a lower (higher) incentive and ability to refinance. For conventional MBS that are TBA-eligible, higher LTV loans provide prepayment protection and typically trade at a premium to TBA during periods of high refinancing activity. To the extent that such high LTV loans include a high percentage of loans that have been recently refinanced, the prepayment function may be further muted. However, in a regime of higher interest rates, due to the dampened prepayment propensity, the duration of such MBS may be longer, resulting in a price concession to TBA securities if the security is not TBA-eligible.

In addition to MBS which have a greater percentage of high LTV loans as a natural byproduct of the origination and pooling processes, there are also designated GSE-insured MBS categories which are specifically designed to pool high LTV loans. These categories were created as a byproduct of Home Affordable Refinance Program (HARP), which was originally established in 2009 (labeled in the financial press as HARP 1.0) and revised in 2011 (HARP 2.0). The objective behind the HARP program was to encourage refinancing by homeowners with negative equity. While the specifics of the HARP program are available elsewhere, the program allows eligible borrowers with LTVs greater than 100%, to refinance.[2] Another salient feature of the HARP program is that

[1] CRA loans are mortgages that qualify for special treatment under the Community Reinvestment Act. The law was intended to ensure that deposits from urban and low-income communities were lent to borrowers either within the community or to low-income borrowers in adequate proportions. While there are no specific rules or guidelines as such, CRA loans tend to have smaller balances, and are generally made to borrowers who have blemished credit histories. Additionally, the income stipulations on CRA eligibility mean that these borrowers have fewer financial resources to access.

[2] The specifics of the HARP program are available at <http://www.makinghomeaffordable.gov> and <http://www.harp.gov>.

loans can only be refinanced once under the aegis of this program. Since such loans are “underwater,” refinancing opportunities for such obligors are limited unless the underlying real estate appreciates to a point where significant positive equity can be built. As such, prepayments for such loans are expected to be significantly slower than TBAs and/or generic averages. The custom MBS market current stratifies high-LTV pools as follows:

- 80–90% LTV;
- 90–95% LTV;
- 95–100% LTV;
- 100–105% LTV;
- 105–125% LTV; and
- >125% LTV.

The last two categories are comprised solely of HARP loans and are not TBA-eligible. In order to differentiate them, the GSEs gives them separate designations (or “tickers”). Thirty-year 105–125% LTV pools are categorized as CQ pools by Fannie Mae and U6 pools by Freddie Mac; loans with LTVs greater than 125% are classified as CR and U9 pools by Fannie and Freddie, respectively. (The GSEs have similar designations for 15- and 20-year HARP pools, although issuance of these products is relatively small.)

As noted above, due to the dampened prepayment propensity feature, the durations of such pools are likely to be significantly longer than those of TBAs. As a result, HARP pools (which are not TBA-eligible) are likely to trade at a discount to TBA-eligible securities in a regime of rising rates. Additionally, the pricing of such securities is also likely to incorporate a liquidity premium, partially due to the aggregate smaller size of this MBS category and non-TBA eligibility.

Credit Quality

The credit quality of loans, as indicated by the FICO score of the obligor, can also be used to stratify loans for pooling as custom MBS under the logic that individuals with lower credit scores face higher barriers to refinancing. However, the effect of this variable may be partially negated during periods of high real estate appreciation as lower credit obligors with low LTVs are able to refinance mortgages.

Determinants of Market Pay-Ups

In most cases, the pay-up is a function of the security’s coupon. While actual pay-ups are a function of extant market conditions, several general observations with respect to pay-ups can be made as follows.

- The higher the coupon, the higher the dollar price of a TBA MBS and the higher the pay-up for similar-coupon customized pools. This pattern of pay-ups is a reflection of the fact that most customized pool valuation revolves around obtaining slower-than-average prepayments to enhance the yield, spread, and carry on premium-priced MBS.
- When the MBS coupon is priced at a discount, pay-ups are minimal. However, as the price of the MBS moves above par, the pay-ups increase. At higher dollar prices, the pay-ups are likely to expand as the current yield advantage emanating as a result of slower prepayments increases at higher price levels. The expansion of pay-ups in rising markets means that the custom pools effectively have longer durations than TBAs and therefore must be hedged using longer hedge ratios, especially for coupons trading at a premium.
- The most common exception to this pattern is in the case of seasoned MBS, where the value of shorter expected average life is reflected in higher pay-ups for lower coupons. For seasoned bonds, contrary to other custom MBS, the relationship between pay-up and price is reversed. Seasoned discount coupons tend to command higher pay-ups. Demand for such MBS is higher due to the associated faster prepayments and shorter average lives and final maturities, particularly in a regime of rising rates when concerns about extension risk plague MBS portfolios. Consequently, seasoned pay-ups tend to be higher for low coupons, in effect increasing at lower dollar prices. Similarly, within a coupon classification, pay-ups are also the highest for the oldest vintages.
- Pay-ups are also affected by near-term prepayment expectations. In general, faster speed expectations for TBAs, particularly when such coupons are priced above par, are likely to result in higher pay-ups for the expected slower prepayment behavior of customized pools. As such, pay-ups on most categories of customized pools are the highest in a regime of fast prepayment speeds. Conversely, in an environment of slower speeds, customized pool pay-ups shrink. These pay-ups are also affected by the prepayment seasoning ramp, which indicates the tendency of newer mortgages to prepay more slowly in the early years of the loan. As such, premium coupon customized pools with brand-new loans will command higher pay-ups than pools with seasoned loans.
- Another key factor in determining customized pool pay-ups is the TBA roll market. Customized pay-ups for a particular coupon tend to be lower whenever TBA rolls are trading "special."[3] In such market conditions, MBS investors can either purchase TBA securities and roll the MBS or invest in customized MBS at a premium over TBA prices. The decision to pay a higher upfront cost for customized

[3] A "special" in TBA rolls occurs whenever the roll levels reflect below-market financing of the MBS. As such, investors can earn a higher rate of return by "rolling" the MBS rather than harvesting the current yield. Such conditions occur in the roll market when substantial hedging activity in a coupon results in increased short sales of MBS coupons. For investors with long positions in an MBS, roll specials have the benefit of enhancing financing-adjusted returns. For hedgers with short positions, specials have the effect of increasing the ongoing costs of hedging.

pools is based upon the projection that the customized MBS will be associated with better carry due to the advantageous prepayment speeds. Therefore, the opportunity cost associated with owning a customized pool is a direct function of the extent of the "specialness" of the roll. Consequently, demand for customized pools is reduced during periods when MBS rolls are trading special, resulting in reduced pay-ups for such pools. Since roll specials result in higher costs of hedging, custom MBS pay-ups may also shrink as dealers attempt to reduce inventories.

- Finally, note that pools eligible to be delivered into TBAs never can trade to a concession (i.e., a negative pay-up) to TBAs, since the pools can simply be delivered into TBA commitments. Nondeliverable products such as FNCQ pools, by contrast, will trade to a concession when the coupon's price is below a modest premium (e.g., a price of 102-16 or less). This makes these pools riskier to trade since there is no floor supporting their value.

Relative Value Assessment of Customized MBS

In the evaluation of customized MBS, some investors will simply assign a slower prepayment speed or speed vector to a custom pool and assess how much incremental yield it offers over TBAs or generic pools run at consensus prepayment speeds. However, this simplistic approach suffers from the fact that the current yield computation depends upon the projection of prepayment speeds and the constancy of speeds and prices over an extended period of time. In assessing and quantifying the relative value of such pools, two approaches are typically used, namely the current carry advantage method and an option-adjusted approach.

Current Carry Advantage of Custom MBS

As noted above, investment in custom MBS involves the payment of a price above TBA prices for the benefit of slower prepayment speeds on premium loans. In the early years of the development of this market subsector, since loan-level prepayment models were not available, the valuation methodology for custom MBS was based upon a comparison of the interest carry of the pool versus that of benchmark TBAs. For MBS pools, carry involves the valuation of all the benefits and costs of owning and financing a position, including coupon and principal payments (both scheduled and unscheduled), reinvestment, and financing costs. By contrast, the carry on a TBA is the monthly "drop," i.e., how much cheaper the later (or "back" month) TBA can be purchased. Investors judging the relative value of a specified pool will look to gauge its value vis-à-vis that of simply holding a long position in TBAs and rolling it forward.

Table 8.2 Carry calculation for hypothetical custom MBS vs TBAs

TBA Roll at Market Levels	
Front-Month Price	100-16
Back-Month Price	100-10
Drop	6/32s
COF at 26% CPR	0.007%
Break-Even Drop at 13% CPR*	**8.75/32s**
Advantage: Break-Even Drop over Market Drop	*2.75/32s*
Custom Pool	
Pay-Up over TBAs	12/32s
Time to Recoup Pay-Up	4.3 months

**Assuming 0.007% COF and reinvestment rate*
Note: Example assumes 350-month WAM Fannie 4s, prepayments for customized pool 50% of TBAs.

Table 8.2 shows a hypothetical example of a typical calculation. It shows that a drop of 6/32s for Fannie 4s results in a 0% cost of funds (a reasonable assumption at this writing) using 26% CPR as the prepayment speed assumption. However, at the same 0% COF, the roll is worth 8.75/32s at 13% CPR (i.e., half of the original speed assumption), or 2.75 ticks about the drop. If a custom pool that could be expected to pay at one-half the speed of the TBA-eligible population required a pay-up of 12/32s, the investor would expect to break even on the purchase after the fourth month. The investor must decide whether a break-even period of four months offers good value, given the risks that (1) the pool pays significantly faster than expected, and (2) the roll does not increase (i.e., the roll does not become "special"). If the roll becomes special, the pay-up must decline in order to continue to give the investor incremental carry on the position after a reasonable break-even period. Therefore, custom pool pay-ups are heavily influenced by conditions in the dollar roll market. Specifically, when rolls are trading special it is more beneficial for investors to buy and roll TBAs rather than invest in custom pools. Moreover, the time to recoup the pay-up is extended for custom MBS currently in the portfolio as long as the roll is special.

Option-Adjusted Spread Analysis

An alternative methodology to the current yield approach is option-adjusted spread (OAS) analysis, which involves the assessment of the differential value of custom MBS in a stochastic framework. The implementation of OAS analysis in the valuation of customized pools has been facilitated by the ongoing development and refinement of loan-level prepayment models. The conceptual underpinning of this approach is that a specified pool should be valued at a similar OAS to TBAs, albeit using a pool-specific prepayment functionality.

The specific steps involved in this methodology are as follows.

- Using current TBA prices, compute current OAS on generic MBS.
- Using custom MBS specific prepayment model and TBA OAS, compute the theoretical price of custom MBS under the assumption that the relevant valuation OAS benchmark is the TBA OAS.
- Compare computed theoretical price of custom MBS to actual price. If the difference between theoretical price and actual price is positive (negative), the custom MBS is cheap (rich) to TBA. The positive (negative) difference may also be viewed as an indicator of the embedded value (overvaluation) of the custom MBS to TBA securities. This indicator may also be used to gauge the relative valuation of various custom MBS across different categories.

An example of the OAS methodology is discussed in Table 8.3. In the first case, where market interest rates are low, the TBA current coupon is priced at 106. At this price, the OAS of the TBA benchmark is 25. As noted above, assuming that the custom pool is also deliverable as a TBA, the price of a similar coupon custom pool, using a pool specific prepayment value and constant OAS to TBA, is 106-16. Hence the additional value emanating due to the slower prepayment characteristics of the custom pool is 16/32nds. As such, the custom pool is cheap (rich) if the actual price of the custom pool is less (greater) than 106-16. In the second scenario, where market interest rates are high and the current coupon trades at a discount, the custom pool should be priced lower than the TBA due to the extension risk associated with the slower prepayments. As such, since this custom pool can also be delivered as a TBA, the lower bound on the price is the TBA price of 96. Therefore, at this price, the OAS of the custom pool is lower than that of the generic MBS. As such, unless the custom pool is priced at a discount to TBA, the pool does not offer

Table 8.3 OAS break-even analysis

For Premium and Discount Custom MBS
Assuming custom pool prepays at 65% of TBAs
Scenario 1: Market rates are low, coupon trades at a premium
Market Price = 106, 30-year Current Coupon Rate = 2.80% TBA OAS = +25 Modeled Price of Custom Pool at +25 OAS = 106-16 Implied Value of Custom Pool = 16/32s Pool offers value over TBAs if the pay up is less than 16/32s
Scenario 2: Market rates are high, coupon trades at a discount
Market Price = 96, 30-year Current Coupon Rate = 5.25% TBA OAS = +15 Modeled Price of Custom Pool at +15 OAS = 95-24 Implied Value of Custom Pool = –8/32s Pool does not offer value over TBAs

any value over TBAs. The fact that the OAS of the custom pool can be lower than that of generic MBS highlights a major difference between premiums and discounts in customized pool evaluation. For higher coupons priced at a premium prices, the likelihood of slower prepayment speeds in a regime of low interest rates leads to the generation of higher OASs. However, for discount coupons, since slower speeds can extend the effective life of the MBS, the OASs are often lower than that of TBAs. Customized MBS such as New York pools and high LTV MBS, which have slower prepayment patterns, irrespective of the level of interest rates, are likely to be most susceptible to this phenomenon.

Despite the fact that the OAS-based valuation paradigm is theoretically sound, the approach is not without limitations. As noted above, the OAS methodology is based upon constant OAS analysis relative to TBAs. In many cases, investors may add an incremental spread to the calculated OAS, particularly if the pool is not TBA-eligible and thus less liquid than the benchmark. The actual spread over the TBA OAS is often calculated in a subjective fashion which may or may not make economic sense. In addition, the OAS-based methodology relies heavily on robust custom pool specific prepayment models. As such, this analysis may be colored by the paucity of data used in the assessment of pool specific prepayment models. Due to the fact that certain variables, such as LTV, can render faster or slower prepayment speeds depending on home price appreciation, the results of this analysis may also be affected by the time period used in the development of pool-specific prepayment models.

Along this vein, the estimation of the duration of customized MBS is another challenging issue in specified pool valuation. While option-adjusted duration is the correct method of assessing the duration of customized pools, this method also requires the existence of robust pool-specific prepayment models. To the extent that such models are not available, empirical durations may be used to obtain an estimate of the interest rate sensitivity of the custom MBS. The estimation of empirical duration involves using nonlinear statistical methodology to estimate the price sensitivity of custom MBS. As such, since this estimation technology is empirically based, it is necessary to regularly update the underlying pricing mechanisms to reflect recent history. Nonetheless, as a general observation, empirical durations closely approximate TBA durations at low premium prices and provide a realistic description of customized pool price sensitivity as long as current market prices do not reflect structural changes which negate historical price relationships.

Challenges and Issues in Customized MBS Valuation

While the focus on obligor and property in the creation of custom MBS leads to superior portfolio performance, it is critical that the analysis of such securities be based upon deep, rich, and relevant data sources, particularly in the development of prepayment models and empirically based evaluations. At the same time, it is also important to have robust post-investment pricing data to maintain current price discovery. In addition to the challenges noted above, the growth of this sector of the MBS market also raises other interesting issues, particularly with respect to the integrity of the TBA market. Within the MBS markets, the TBA market has been considered the valuation benchmark, as this category comprises the bulk of newly originated collateral. However, given investor demand for custom MBS, originators are provided with the demand and the monetary incentive to engage in the creation of custom pools. As such, during periods of high demand for such pools, which likely occurs when rates are falling and the convexity of portfolios is hampered, it is also likely that the TBA market is "adversely selected." This means that the TBA market is comprised of pools that cannot be custom-pooled, making the TBA market more negatively convex. Finally, as interest rates increase and pay-ups shrink due to reduced demand for improved convexity, customized pool investors have to be cognizant of the potential for the impaired liquidity of such pools in a low-volume environment.

Key Points

- Various obligor and property attributes inherent in mortgage loans lead to predictable and observable differences in MBS performance and associated performance measures such as duration and convexity. This has led to the growth of a sector of the MBS market generally described as the "customized MBS" sector.
- The most significant manifestation of this growth has been in the conventional fixed-rate MBS market.
- The concept of custom MBS is based upon identifying obligor and property attributes that result in superior performance.
- Traditional stratification factors have been the age of loans, gross weighted average coupon (WAC), and geographic location.
- Custom MBS have also been created based on attributes such as loan size, occupancy status, credit quality characteristics (such as FICO score), and loan-to-value ratios. The effect on prepayments of a combination of these factors results in a multiplicative effect of the convexity characteristics of the subject MBS.
- Customized pools have also been used as collateral for structured MBS transactions, with pricing on certain tranches such as interest-only (IO) securities predicated on the advantageous prepayment behavior of the loans.
- Depending upon the characteristics of the underlying loans, such securities are typically priced at a premium or pay-up to the generic MBS or to-be-announced (TBA) market.
- The earliest manifestation of custom MBS was specified pool trading, where factors such as gross WAC, age, and geographic location were used as stratification parameters.
- Low gross WAC pools have dampened refinancing incentives, resulting in slower prepayments and superior convexity.
- Premium new loans trade at pay-ups to TBA due to the tendency of such loans to prepay more slowly in the initial months after origination. This sector also stratifies on various levels of seasoning.

- The geographic location of a property can also affect the costs of refinancing the underlying loan and thereby impact the actual decision to refinance. In certain states, such as New York and Florida, the transaction costs of refinancing are significantly higher than national averages, as both these states levy taxes on refinancing transactions that are not levied elsewhere. As such, these idiosyncratic geographic factors negatively affect the refinancing decision resulting in muted prepayment behavior and improved convexity characteristics.
- The inclusion of loan size as a stratification parameter has manifested in the creation of "low-balance" MBS.
- Due to the fact that the refinancing process involves certain upfront fixed costs, lower-balance loans require a more than proportionate decrease in interest rates to make the refinancing process economically justifiable, resulting in slower prepayment speeds.
- Premium low-balance MBS command a premium over TBAs, with the size of the premium expanding with higher coupons. Additional expansions of the pay-ups are also likely to occur during periods of high refinancing due to increased demand for improved MBS convexity.
- With respect to loan size, stipulations of $85,000, $110,000, and $150,000 maximum original balance are an informal set of standards that have been adopted over the years for conventional 30-year MBS.
- In the case of 15-year MBS, where loans tend to be smaller in size, the market standard limits are $75,000, $110,000, and $130,000, respectively. These stipulations are referred to as "low-balance," "medium-balance," and "high-balance," respectively in the specific maturity category.
- The loan-to-value ratio (LTV) of a loan is a proxy for the equity of the property owner. A higher LTV (lower LTV) implies less (more) equity and results in a lower (higher) incentive and ability to refinance.
- For conventional MBS that are TBA-eligible, higher LTV loans provide prepayment protection and typically trade at a premium to TBA during periods of high refinancing activity.
- The credit quality of loans, as indicated by the FICO score of the obligor, is also used to stratify loans for pooling as custom MBS under the logic that individuals with lower credit scores face higher barriers to refinancing and hence improved convexity characteristics. Such loans are priced at a premium to relevant TBA benchmarks.
- The higher the coupon, the higher the dollar price of a TBA MBS and the higher the pay-up for similar-coupon customized pools. For discount MBS, pay-ups are minimal. However, as the price of the MBS moves above par, the pay-ups increase. Pay-ups are also affected by near-term prepayment expectations.
- In general, faster speed expectations for TBAs, particularly when such coupons are priced above par, result in higher pay-ups for the expected slower prepayment behavior of customized pools.
- Pay-ups on most categories of customized pools are the highest in a regime of fast prepayment speeds.
- Customized pay-ups for a particular coupon tend to be lower whenever TBA rolls are trading "special", as investors can either purchase TBA securities and roll the MBS or invest in customized MBS at a premium over TBA prices.
- The relative value assessment of custom pools can be determined by comparing the current yield advantage of custom pools occurring due to slower prepayments over TBAs.

- An alternative methodology to the current yield approach is option-adjusted spread (OAS) analysis, which involves the assessment of the differential value of custom MBS in a stochastic framework.
- The growth of the custom MBS sector also raises questions about the integrity of the TBA market, as during periods of high demand, the TBA market may be comprised of adversely selected pools that cannot be custom-pooled. As such, the TBA pricing benchmark may become more negatively convex.

CHAPTER 9

SINGLE-FAMILY RENTAL DEALS

DEBRA CHEN

After reading this chapter you will understand:

- single-family rental securitization is a new sector that emerged after the subprime crisis and has attracted attention and strong interest from investors;
- single-family rental securitization has used CMBS-like structures and the loan is backed by a portfolio of single-family homes;
- there are multiple parties involved in each securitization and it is important to understand their responsibilities;
- both cash-flow-based approach and home-price-appreciation-based approach have been used to analyze the risk due to the hybrid nature of the sector;
- the single-family rental sector has limited performance history and therefore many assumptions used in the analysis of this sector are based on the historical performance of the multifamily units;
- although the single-family rental securitization market has expanded rapidly in recent years, the sector is still facing many risks and concerns related to the viability of the business.

Single-family rental (SFR) business used to be mom-and-pop shops. There are now over 14 million single-family rental units in the United States. The cycle of lower home prices, lower home ownership rates, and falling credit availability has led to a rapid growth in the size of the home rental market. After the collapse of the housing market, this market presented unique opportunities for institutional investors. Institutional investors started to step into the single-family rental market in 2009.

The homeownership rate in the United States has hovered around 68% since 2000 (see Figure 9.1). At the peak of the homebuying boom it approached 70%, but since the bust it has trended back down. The rate not only fell all the way back to the long-term average but also continued to fall lower than that. The recession and

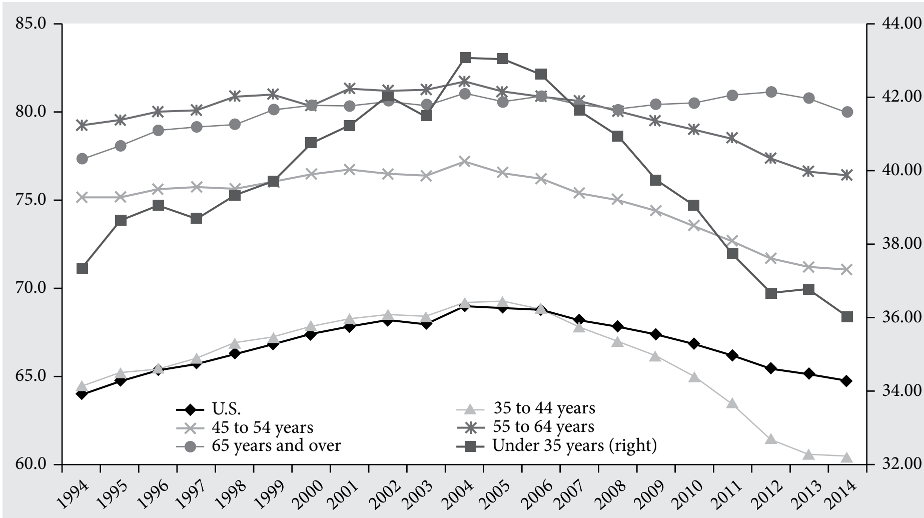

FIGURE 9.1 Homeownership rate by age group and year

Source: US Census

recovery had a bigger effect on the ownership rate of young adults than on that of older adults. Many young people struggled in the recession and moved in with their parents. There are roughly 15% fewer homeowners under the age of 35 and 35–44 than there were in 2005. The ownership rate fell not just for young adults, but also for some older age groups as well. For instance, the percentage of 55–64-year-olds living in households headed by their children or other relatives went up. As homeownership falls, demand for rental housing is booming. The vacancy rate for rental homes in the US fell to 7.1% in first quarter of 2015 from a level of 10% during the housing boom.

The residential market recovery following the subprime crisis has bifurcated. The wealthy cohort and investors have driven up home prices, while younger demographics and impaired credit borrowers have leant more toward rentership. Laurie Goodman's team at the Urban Institute has put together a credit availability index (Figure 9.2) by evaluating the credit risk associated with loans originated at a given point of time.[1] According to their study, the mortgage market not only ceased lending risky loans after the crisis, but was also less willing to lend to credit-impaired borrowers. Overall risk related to newly originated loans has dipped below pre-crisis levels. Due to tight credit availability, we have observed that recent pickups in household formation have mostly been home renters. This data suggests that a strengthening job market may have led to the trend of growth in household formation and accelerated the demand for rental properties.

[1] Wei Li and Laurie S. Goodman, "A New Mortgage Credit Availability Index," *Journal of Structured Finance* 20/4 (2015): 67–83.

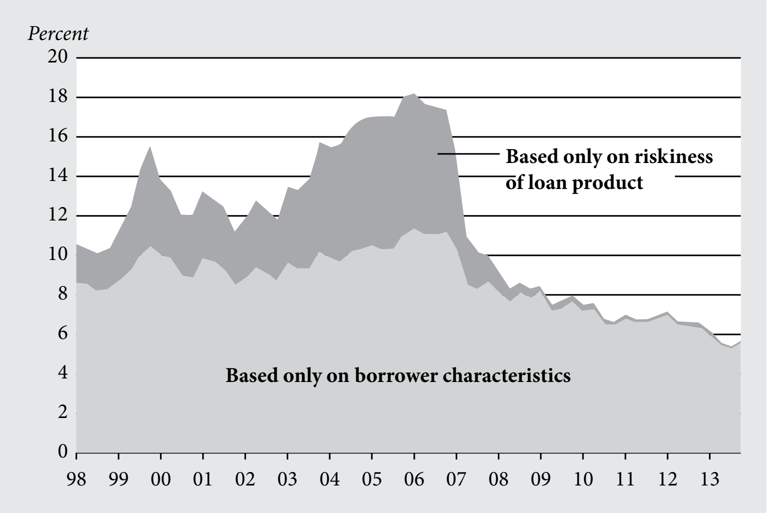

FIGURE 9.2 Mortgage credit availabilities measured by default risk taken by the mortgage market over time

Source: Urban Institute HCAI Index

Table 9.1 Institutional investors

	APR	AH4R	Colony	IHSFR	PROG	SBY	Tricon	Waypoint
Homes Owned	7,205	27,173	16,761	45,000	10,300	5,987	4,274	9,122
States	13	22			12			
Average Age	19	12			13	27	37	32
Average Size	1,760	1,969	1,853			1,165	1,474	1,760
Average Investment	139,748	170,000	170,000	193,000		139,000	113,000	147,000
Average Monthly Rent	1,222	1,393	1,390	1,312		1,170	1,140	1,416
Total Occupancy	89%	86%	74%	87%	80%	90%	85%	78%
Stabilized Occupancy	95%	95%			96%	95%		
Portfolio Rental Yield	11%	10%						

Source: Issuer company websites, offering documents

After a period of rapid expansion from 2012 to 2014, the biggest investors have accumulated more than 120,000 single-family units. Table 9.1 shows the comparison between the top institutional investors.

Most of this growth has been organic. Some investors have moved away from areas that have recovered rapidly after the crisis and moved into geographies where the residential markets still provide attractive rental yields. As the opportunity for large-scale discount purchase has diminished, recent portfolio expansion has been mostly through the auction and retail channels. Some institutional investors have started establishing new channels for future growth.

1. Some have acquired nonperforming loan portfolios as a potential way to grow.
2. Larger investors are looking out for small- to medium-scale portfolio acquisition opportunities.
3. Some larger investors, such as Blackstone, Colony, and Cerberus, have set up platforms for smaller investors who own small portfolios of rental properties.
4. Some investors have set up their programs as buy-to-own.

In 2016, the portfolio comprised of all institutional investors will continue to grow at a slower pace. Portfolio acquisition and purchase through multiple listing service (MLS) channels are likely to be the biggest drivers of the next phase of growth.

Several major investors are now adjusting their business strategy in response to the stabilization in the residential market. While they continue to expand their portfolios opportunistically through traditional auction and retail channels, they are shifting their focus on improving portfolio performance and containing costs. Many of them have internalized their property management operations. The vacancy rate of the stabilized portfolio has dropped below 5% in recent reports. As a result, some operators are now testing rental increase to further enhance their yields.

Securitization Structure

Single-family rental securitizations are securitizations backed by pools of single-family rental properties. SFR deals have maintained CMBS-like structures—the certificate is carved into multiple classes, and the primary form of credit support comes via tranche subordination. Most transactions have been structured as a single floating rate loan to one borrower. The loan is then tranched into six classes of notes ranging from AAA to BB (see Figure 9.3). Usually, the loan has two-year terms with three one-year extensions. Generally, each loan has been underwritten at 65%–75% of the Broker Price Opinions (BPOs). In more recent deals, it has been structured with a retained 5% principal-only subordinated class to comply with European risk retention rules to attract European investors.

Both the interest and principal are distributed to the certificates in sequential order. Realized losses are allocated in reverse sequential order. Once a realized loss is allocated to a note, no principal or interest will be distributed with respect to the written-down amount. The early deals have built-in 1% amortization per year. Therefore, senior notes have a slightly shorter weighted-average life than subordinated notes. This feature is removed for the later deals.

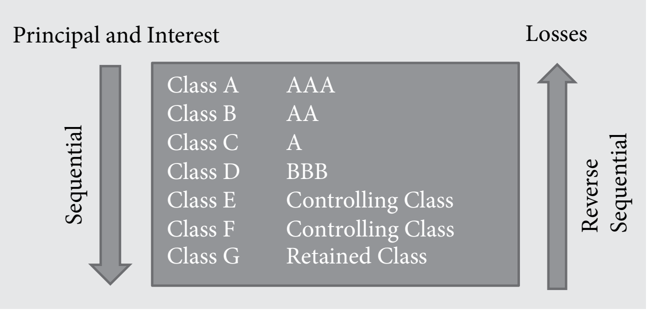

FIGURE 9.3 Deal structure

Source: Offering documents, Kroll Bond Rating Agency

Sponsors are required to purchase an interest rate cap agreement to protect investors from interest rate risk and meet the DSCR (debt service coverage ratio) target of 1.2 for the two-year term and for each extension. Interest rate risks are fairly remote in these deals and assumed interest rate cap strikes are much higher than the current interest rate. Some deals have a built-in DSCR hurdle (1.2 ×) and some have a debt yield (DY) trigger −85% of the closing level. In the event that the DSCR or DY fall below the given hurdles, the deal will redirect all the excess cash to investors until the trigger has achieved a level higher than the hurdle level typically for two consecutive months. The sponsor may also make a voluntary prepayment to the investors in order to cure the breach.

The loan can be prepaid in whole or in part, subject to prepayment requirements. For any prepayment that occurs prior to the lockout period, the borrower needs to pay a spread maintenance premium. The issuer is often allowed to release properties at a given release price based on the percentage of the initial loan balance. For example, if the sum of the original allocated loan amount of all released properties is less than 10% of the initial loan balance, then the release premium is 5% of the allocated loan amount. Usually, the premium will go up as the percentage increases. If a property fails to comply with certain property covenants and becomes a disqualified property, the borrower will be required to buy out the property from the portfolio. Some early transactions have built-in tenant covenants as well, which are removed in later deals.

In addition to certain events of default that are generally consistent with the definitions used in commercial loan agreements, the following also constitute events of default: (a) the sponsor fails to pay off a disqualified loan, (b) the borrower fails to maintain an interest rate cap, and (c) the sponsor or any replacement guarantor fails to maintain the minimum net asset. While an event of default is occurring, the lender can declare the loan immediately due and payable. In addition, the interest on the loan will step up. Further, during an event of default, the lender is permitted to apply any collections from the properties and reserve accounts toward the payment of the notes.

The controlling class is usually the most subordinated of the class E and F certificates that has an outstanding balance at least equal to 25% of the initial certificate balance of such a class. The controlling class may request a vote to replace or direct the special servicer as well as having certain consent rights relating to the properties. However, the control right does not transfer to bonds higher in the capital structure as the losses erode the subordinated bonds.

The loan sponsor will provide a non-resource limited guaranty with respect to losses and expenses in connection with fraud or intentional misrepresentation. Under the sponsor guaranty, the sponsor will be responsible for the principal up to a capped amount. Some deals have stronger guaranties than others. For instance, American Home 4 Rent provides a guaranty for the full amount of the debt of its transaction.

To date, all top eight institutional investors have issued at least one deal in the securitization market (see Table 9.2). Due to favorable pricing, securitization is the preferred means of funding for institutional investors. The issuing of the first multi-borrower transaction recently has opened up another potential market.

Table 9.2 Overview of SFR deals

Deal	Coupon	Original Term	Full Extension
IHSFR 2013-SFR1	1ML + 176	2	5
CAH 2014-1A	1ML + 168	3	5
AH4R 2014-SFR1	1ML + 163	2	5
IHSFR 2014-SFR1	1ML + 189	2	5
SBY 2014-SFR1	1ML + 195	2	5
CAH 2014-2A	1ML + 173	2	5
IHSFR 2014-SFR2	1ML + 195	2	5
ARP 2014-SFR1	1ML + 206	2	5
AH4R 2014-SFR2	4.27%	10	10
PROG 2014-SFR1	1ML + 217	2	5
IHSFR 2014-SFR3	1ML + 249	2	5
AH4R 2014-SFR3	4.47%	10	10
SWAY 2014-1	1ML + 248	2	5
IHSFR 2015-SFR1	1ML + 247	2	5
PROG 2015-SFR1	1ML + 220	2	5
AH4R 2015-SFR1	4.21%	10	10
IHSFR 2015-SFR2	1ML + 211	2	5
TAH 2015-SFR1	1ML + 208	2	5

Source: Offering documents

Collateral Characteristics

Geographically, the underlying loan collateral is primarily derived from single-family rental homes located in states that experienced a significant degree of pricing stress. The top three states, Arizona, California, and Florida, represent 54% of the exposures. The properties consist of mainly three- or four-bedroom homes with two or more bathrooms and are roughly 1,800 sq ft in size. Home age varies by issuer, although most pools carry an average age in excess of 25 years. American Homes 4 Rent and American Residential Properties have been the exception, reporting an average home age of just 12 years. Younger collateral should generally be a credit-positive factor, as ongoing maintenance should be less common. A portion of each securitized portfolio also contains modest exposure to swimming pools. In addition to higher maintenance and repair costs, their presence can serve as potential hazards and add to landlord liability. Silver Bay has been successful in shifting the maintenance responsibility to occupants; however, this still does not reduce potential landlord liability.

Parties Involved in Securitization

There are four important parties (Figure 9.4) involved in an SFR transaction as they can influence the performance of a deal. We will go through them one by one here.

Master Servicer

The master servicer is responsible for servicing the loan and for making principal and interest advances when there is no default or reasonable foreseeable default that would require transfer of servicing to the special servicer.

Special Servicer

The special servicer will step into master servicer's position if the servicing is transferred. Usually, the special servicer is a specialist in dealing with defaulted mortgage loans with the primary responsibility of maximizing value to the trust. The special servicer will typically work with the borrower to cure the loans or modify the loan to achieve the goal. If this cannot be achieved, the special servicer can decide to liquidate the properties. If this happens, it is most likely that they will foreclose on the pledged equity through an auction. If a buyer cannot be found, the trust will become the owner of the issuer and the special servicer will have full control of the properties. The special servicer can then foreclose on the mortgage loan, which will require the servicer to file

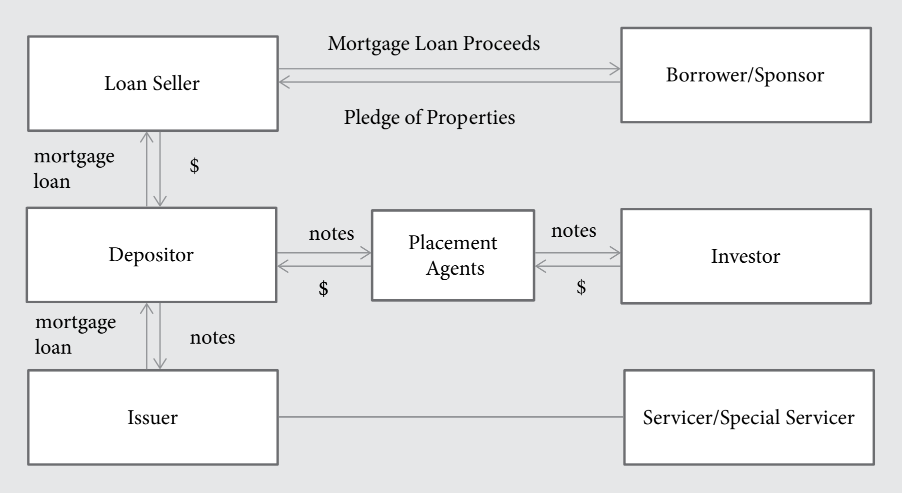

FIGURE 9.4 SFR securitization structure

Source: Offering documents, Kroll Bond Rating Agency

the foreclosure at each county in which the pool has properties. The special servicer can accept a cash bid for the related properties, or the issuer and trust can receive the cash proceeds in exchange. The foreclosure timelines will depend on whether the county is in a judicial or nonjudicial state. Judicial states generally take longer to foreclose on loans than nonjudicial states.

Property Manager

The property manager plays a critical part in loans as they are responsible for all aspects of operations. A good and experienced property manager can keep the turnover rate low, push the rent growth, and reduce ongoing maintenance costs. Most borrowers have internalized the property management functions and handle all the renovation, repairs, leasing, tenant screening, and tenant services through their own teams.

The servicer can terminate the property manager on behalf of the trust under certain circumstances and replace it with a qualified replacement manager. Generally, cash flow disruptions and temporary performance deterioration are expected during the transfer if the property manager is replaced.

Sponsor

The sponsor is important, especially when it comes to refinance time. The sponsor's ability to access the capital market and repay the loan is critical for securities in a downturn scenario. In addition, the sponsor's investment strategy and commitment to the sector may also lead to performance differentiation. Although the loan is non-recourse to the sponsor, its ability and willingness to preserve the value of the properties is important.

Deal Analysis

We can analyze the deals using two different methods, the cash-flow-based approach and the home-price-value-based approach. The cash-flow-based approach is usually used to determine the probability of default on the loan. The home-price-value-based approach is used to determine the recovery if the loan defaults.

The cash-flow-based approach calculates the net operating income (NOI) and net cash flow (NCF). The first step is to forecast the revenues. For the initial year, gross potential rental income can be based on each property's contractual rent because most deals are issued with 100% occupancy rate. The rent price of single-family properties has appreciated around 2%–4% in recent years, but it has appreciated slower than multi-family units because most property managers are trying to retain the good tenants and reduce turnover rate. Rent growth in the multi-family space has slowed down since 2012 because of the heavy rental supply from the new multi-family constructions. This may not have a direct impact on rent growth in the single-family rental market because such constructions tend to be located in different neighborhoods and appeal to a different type of renter.

To determine the vacancy rate, we can look at the multi-family vacancy rate to inform our assumptions, as SFRs have a limited vacancy history as a new asset class. With only a couple of years of data, it is still too early to fully access the performance of the sector and nuances between the various deals, especially as it is a rather new sector which has not experienced a rental market downturn. Recent reports indicate that SFR deals are performing above expectations, which may be related to the strong rental market. In particular, vacancy rates have stabilized around 5% (Table 9.3), well below initial assumptions. Table 9.4 shows the delinquency rates across the deals, which are defined as post due more than 30 days and still owing a minimum amount. Overall, the delinquency level remains low. A rising delinquency level may result in a rising vacancy rate later and it is costly to evict bad tenants in certain states. Within the sector, we have begun to see differentiation across the deals due to collateral and sponsor strength. To account for lack of data and longer downtime between tenants, investors may want to apply more stress for single-family rentals compared to multi-family portfolios in the downtown scenario.

Moving to the expenses side, operating expenses consist of real estate tax, property management fee, homeowner association (HOA) fees, insurance, repairs and maintenance, turnover cost, and leasing and marketing costs. Depending on the location and condition of the property, carry costs and repair costs can be significant. Some of these expenses can alter the rental yield substantially. Property tax and management fees are the two big components of the carry cost. Property tax tends to be higher in states with low or no income tax.

Table 9.3 Vacancy rate

	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15
AH4R 2014-SFR1				4.0	5.8	5.9	6.2	6.4	6.6	6.8	6.5	5.1
AH4R 2014-SFR2									4.8	5.7	6.0	5.7
AH4R 2014-SFR3										4.4	5.0	5.5
ARP 2014-SFR1							4.9	7.3	9.2	8.7	9.1	10.0
CAH 2014-1		3.9	5.4	6.9	6.9	8.4	9.1	9.2	7.2	5.9	4.6	4.0
CAH 2014-2				0.9	2.0	3.6	3.3	4.1	4.7	5.2	5.9	6.4
IH 2013-SFR1	5.8	4.3	3.4	3.7	3.2	3.0	3.6	2.7	2.9	3.1	3.8	4.3
IH 2014-SFR1			7.1	6.6	6.5	4.6	4.3	3.3	3.1	3.5	3.0	3.3
IH 2014-SFR2						3.9	4.0	3.7	3.3	3.5	3.6	3.0
IH 2014-SFR3									3.4	3.8	3.2	3.0
IH 2015-SFR1											4.9	4.8
PRD 2014-SFR1								1.7	3.3	5.3	5.5	6.3
PRD 2015-SFR1												1.5
SBY 2014-1						3.9	5.4	6.2	6.5	6.4	5.9	5.2
SWAY 2014-1										5.3	5.6	5.3

Source: Morningstar Credit Ratings, LLC

Table 9.4 Delinquency rate

	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15
AH4R 2014-SFR1				1.2	0.9	0.6	0.8	1.3	2.7	2.4	1.2	1.4
AH4R 2014-SFR2									1.7	2.1	1.6	1.6
AH4R 2014-SFR3										1.4	0.7	0.8
ARP 2014-SFR1							0.7	1.7	1.6	1.6	2.5	1.7
CAH 2014-1		0.8	0.7	1.5	1.7	1.1	2.0	1.3	1.5	2.0	1.7	0.6
CAH 2014-2				0.1	1.5	1.5	2.3	1.5	1.9	1.9	1.6	1.2
IH 2013-SFR1	0.3	0.9	0.4	0.6	0.4	0.6	0.7	0.7	0.8	0.9	0.8	0.6
IH 2014-SFR1			0.4	0.5	0.7	0.8	0.8	0.8	1.0	1.0	1.0	0.8
IH 2014-SFR2						0.9	1.0	1.1	1.1	1.1	1.3	1.0
IH 2014-SFR3									1.0	0.8	0.8	0.8
IH 2015-SFR1											1.8	1.5
PRD 2014-SFR1								0.7	1.1	0.5	1.0	0.8
PRD 2015-SFR1												0.5
SBY 2014-1						1.0	0.7	0.8	1.1	1.1	1.1	1.3
SWAY 2014-1											0.4	0.6

Source: Morningstar Credit Ratings, LLC

Occupancy rates have benefitted from homeownership preference, as well as continued supply and demand imbalance in the rental market. Property managers have successfully retained the majority of renters in these securitized deals. The actual retention rates (see Tables 9.5 and 9.6) are higher than the estimation (roughly 67%) used as the deals originated. Therefore, the turnover cost and the expense associated with leasing and marketing have been lower than expected.

Repair and maintenance cost is the hardest to forecast because it is harder to achieve the same economic scale as the multi-family units. This is especially true for smaller operators who are unable to achieve economy of scale in negotiating with the vendors and contractors. Generally, newer houses should require less repair and capital expenditure at the front. If the sponsors have spent more initially to renovate the properties, the ongoing maintenance costs should also be lower. It also depends on the quality of the tenants and location of the houses. Many deals have seen higher repair and maintenance costs than original budgets. Some issuers are able to pass the additional expenses to the renters. Therefore, the profit margins have seen little impact.

The income-based market value is calculated based on the issuer's NCF divided by a capitalization rate. Capitalization rates in the current market environment range from 5% to 7.5%. They can move quickly as market conditions change and the interest rate rises. The results of the property cash flow analysis are key inputs to determine default probability at the maturity wall.

After calculating the default probability, the next step is to calculate the liquidation value and losses. Unlike the CMBS analysis, which uses income-based valuation to estimate the losses, we are using the home-price-based approach to estimate the losses because the servicer in such circumstances can seize the pool of single-family properties and liquidate the portfolio. For the HPI-derived value, an MSA-level property value discount for each asset can be applied for each property to calculate the stressed values depending on the investor's housing view.

Risk of the Sector

In this section, we want to address some risks that the sector is facing. In the first two scenarios, the risks are more related to the viability of the sector, which does not necessarily present any credit risk to the investors. In the last scenario, investors are facing significant extension risk and uncertainty associated with the foreclosure process because it has never been tested before.

Regulatory Intervention

The demand for single-family rentals is robust, largely due to the inability of many renters to obtain mortgages. However, the American dream of owning a house has not

Table 9.5 Retention rate

	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15
AH4R 2014-SFR1				75.2	78.5	79.0	71.2	79.0	75.7	75.0	78.2
AH4R 2014-SFR2									70.1	72.5	80.9
AH4R 2014-SFR3										74.6	77.0
ARP 2014-SFR1							76.5	74.5	81.9	73.1	82.8
CAH 2014-1		82.2	76.2	79.0	78.4	78.9	79.6	81.2	84.7	71.4	83.7
CAH 2014-2				80.2	76.1	85.8	77.4	82.6	80.6	82.1	79.0
IH 2013-SFR1	75.7	80.4	81.1	74.6	67.9	73.4	62.3	86.6	76.7	82.9	81.7
IH 2014-SFR1			72.9	74.9	74.1	77.9	79.7	76.6	76.9	75.4	81.8
IH 2014-SFR2						79.2	76.0	79.5	79.6	86.3	85.0
IH 2014-SFR3									73.2	82.5	86.2
IH 2015-SFR1											79.9
PRD 2014-SFR1								83.5	66.9	72.2	74.2
PRD 2015-SFR1											
SBY 2014-1						77.5	72.3	74.6	74.6	71.7	71.3
SWAY 2014-1											78.3

Source: Morningstar Credit Ratings, LLC

Table 9.6 Retention rate with MOM lease

	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15
AH4R 2014-SFR1				59.4	76.8	80.2	74.8	80.6	79.4	87.0	89.0
AH4R 2014-SFR2									81.9	88.6	91.1
AH4R 2014-SFR3										79.5	85.1
ARP 2014-SFR1							83.0	81.3	94.9	95.0	90.4
CAH 2014-1							83.5	88.1	90.8	85.2	76.6
CAH 2014-2						90.9	86.5	90.8	88.8	87.5	84.8
IH 2013-SFR1	81.4	79.2	70.0	81.0	67.6	78.6	88.5	87.5	76.0	88.9	74.3
IH 2014-SFR1			65.8	70.9	81.7	72.4	81.9	76.1	75.9	86.4	84.2
IH 2014-SFR2						71.1	76.7	84.2	75.0	65.7	75.8
IH 2014-SFR3									70.3	79.3	75.8
IH 2015-SFR1											82.4
PRD 2014-SFR1								84.8	88.3	86.6	85.0
PRD 2015-SFR1											
SBY 2014-1						87.8	86.9	91.7	91.9	96.2	90.6
SWAY 2014-1											90.5

Source: Morningstar CreditRatings, LLC changed. Recent research from housing site Zillow found that young adults are actually more eager to own a home than older Americans. A number of other surveys have shown that the vast majority of millennials would love to own a place of their own. The demand for rental properties will wane if regulatory intervention could attempt to provide credit and promote homeownership. In this scenario, it won't result in any losses in the trust, but the SFR securitization market may go away. It raises a question on this asset class's viability in the future.

Institutional Investor Commitment

In another scenario, home prices continue to rise to a point where the rental yields on investment properties are no longer compelling for institutional investors. They then decide to exit the market by selling the underlying assets at the maturity of the loan. Similar to the previous scenario, this scenario does not present a credit risk to bond investors.

Extension and Refinance Risk

The third scenario is that the rental demand wanes, property value falls, and operating costs are higher than expected. In this case, the net cash flow of the property decreases and results in lower debt service coverage ratio. This could also trigger higher turnover on SFR properties. Such a scenario would reduce the ability of the sponsor to refinance the loan at maturity and increase the likelihood of default before or on maturity. If a loan defaults, the loss can be significant in combination with declining housing prices.

The size of the rental market has obviously grown and should continue to do so and the market will likely see more institutional buyers. The use of securitization to help finance the large-scale purchases that have been made and those that will be made in the future is a natural evolution for a market of this size and one with the growth that it has shown. As we have already discussed, institutional investor participation in the market is still relatively small. The next phase of single-family securitization will be the ability for smaller investors to access the market, even single-property investors. Many big institutions are already offering loans to small to medium investors. It may still take a while for this market to develop.

Key Points

- Single-family rental business started to attract institutional investors after the subprime crisis.
- Typical deals consist of six classes of non-amortizing floaters, which are callable in two years.

- Principal and interest on deals flow top-down, while losses are allocated bottom-up.
- Credit risk in these deals is different than for RMBS: (1) principal and interest are paid out of the rent cash flows and (2) refinance risk is a concern if the sponsor defaults as a result of higher vacancy rate and costly repair and maintenance.
- In a default, the special servicer will work with the sponsor for a modification or liquidation. However, the liquidation process has not been tested.
- Credit risk can be evaluated by calculating net operating income and recovery can be calculated by estimating liquidation values in various home price appreciation scenarios.

CHAPTER 10

GSE CREDIT RISK TRANSFER DEALS

DEBRA CHEN

After reading this chapter you will understand:

- credit risk transfer deals are a part of FHFA's initiative to bring private capital back to the mortgage market;
- credit risk transfer bonds are unsecured obligations of the GSEs;
- the cash flows of credit risk transfer bonds are linked to the performance of the reference mortgage pools;
- deal structure is different from traditional non-agency RMBS due to default definition and fixed severity schedule;
- money managers are the major investors of senior mezzanine notes while both hedge funds and money managers are active in the lower credit notes;
- there is a concern about the liquidity of the sector because dealers are less incentivized to hold inventory with dollar-for-dollar capital charge for all tranches.

As part of the Federal Housing Finance Agency's initiative to bring private capital back to the mortgage market, Fannie and Freddie have issued several credit risk transfer (CRT) deals, where part of the credit risk in the government-sponsored enterprises' (GSEs') wrap business is transferred to private investors. Freddie Mac debuted its first risk-sharing security in July 2013, followed by Fannie Mae's version in October. This new asset class has received wide attention as this new class of bond presents investors with opportunities to access US residential mortgage credit, while the outstanding balance of legacy non-agency residential mortgage-backed securities continues to shrink. The GSEs have issued a combined total of $27 billion of credit debt securities to date. As of early 2016, the GSEs are each planning to issue at least one deal of each series per quarter going forward.

Deal Structure

The CRTs are uncapped LIBOR-based floaters that are unsecured obligations of the GSEs with a 10-year maturity. Although cash flows are linked to prepayments and defaults of the reference mortgage loans, the securities are debentures, not mortgage-backed securities. Freddie's risk transfer shelf is Structured Agency Credit Risk (STACR), while Fannie's is Connecticut Avenue Securities (CAS). The first STACR and CAS deals both contained two mezzanine bonds, M1 and M2, as well as one senior and one bottom residual tranche (Figure 10.1). The M1 tranche in these deals has generally been rated A/BBB by the ratings agencies, while the last cash flow tranche was usually unrated. Although we refer to the senior bond and residual as classes receiving principal and interest, these are not actual bonds that are sold to investors. Rather, they are used only for the purposes of calculating the cash flows to the mezzanine bonds. They can be thought of as effectively retained by the GSEs. By issuing these notes, GSEs effectively transfer the credit risk of a reference pool of loans to investors who buy the mezzanine notes of the deal. Freddie Mac and Fannie Mae are required to retain a portion of M1, M2, and first-loss pieces to align their interest with the investors'.

Within each credit risk transfer program, there are also different series. For instance, DN series from the STACR program contain lower loan-to-value (LTV) loans while HQ series are backed by high LTV loans.

The underlying reference pools consist of 30-year fixed-rate mortgages wrapped by the GSEs, with particular credit constraints. Using the first STACR deal as an example, the underlying loans had the following characteristics, among others:

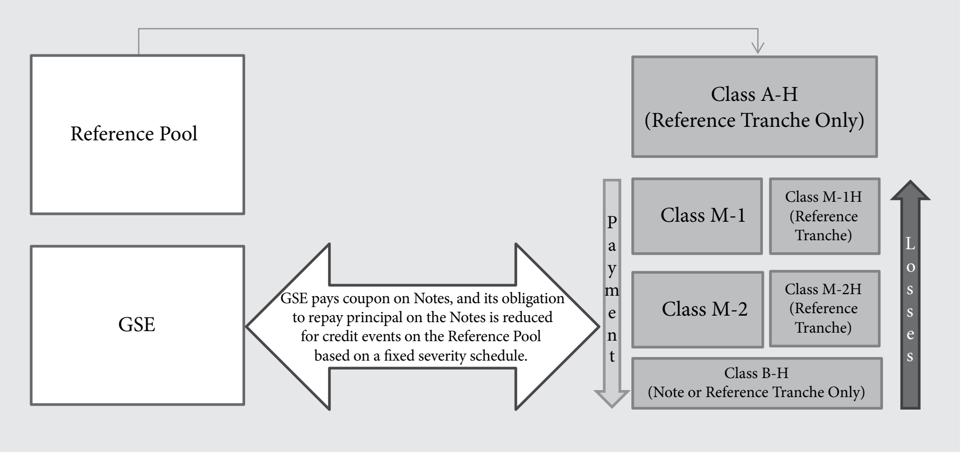

FIGURE 10.1 Credit risk transfer deal structure

Source: Fannie Mae; Freddie Mac

- a fully amortizing, 30-year fixed-rate first lien mortgage with full documentation;
- LTV between 60 and 80, inclusive of 80;
- combined LTV less than 95;
- no mortgage insurance;
- no HARP loans or loans from any other affordable mortgage program;
- not under a government program;
- loans originated in selected period;
- not from a recourse state;
- never delinquent;
- balance of at least $5,000 as of the month prior to issuance.

For the high LTV deals, using the first STACR HLTV deal as an example, the underlying loans had the following characteristics, among others:

- 30-year fixed-rate with full documentation loans;
- LTV between 80 and 95, exclusive of 80, but inclusive of 95;
- with mortgage insurance;
- combined LTV less than or equal to 97;
- no HARP loans or loans from any other affordable mortgage program;
- not under a government program;
- loans originated in selected period;
- not from a recourse state;
- never delinquent;
- balance of at least $5,000 as of the month prior to issuance.

The higher LTVs on HQ deals increase the expected default relative to DN series. However, offsetting this risk is a lower share of refinance and investor loans in the high LTV deals. Additionally, the high LTV deals are more geographically diversified, with only 10% of loans in California versus 25%–30% in the low LTV deals.

Instead of traditional defaults, which are thought of as REO liquidation, short sales, or foreclosure sales, losses will be allocated based on credit events, defined roughly as 180-day delinquency or short sale/REO, whichever comes first. In practice, this means that once a loan hits 180-day delinquency, it will drop out of the pool and create an immediate loss. Losses flow through from the bottom up, first hitting the residual piece, then the mezzanines.

Freddie and Fannie follow specified severity schedules based on cumulative credit events as shown in Table 10.1 rather than the actual proceeds from the loan liquidation. In the Freddie deals, the first 100 basis points (bps) of credit events are assigned a 15% severity. The next 100 bps have a 25% severity; after that, the severity is 40%. Fannie's schedule is similar but lower, at 10%, 20%, and 40%.

The cash flows of these bonds rely on prepayments and credit events on the reference pool. Interest is paid *pro rata* to all mezzanine bonds. Unlike most non-agency structures,

Table 10.1 Scheduled loss severities

Cum Credit Events	STACR DN	STACR HQ	CAS	CAS HLTV
<1.0%	15%	10%	10%	10%
1.0–2.0%	25%	20%	20%	20%
2.0%–3.0%	40%	20%	40%	20%
3.0%–5.0%	40%	25%	40%	25%
>5.0%	40%	40%	40%	25%

Source: Deal documents

Table 10.2 Cumulative default trigger schedule

Cumulative Default Trigger	
Payment Date	Cumulative Net Credit Events %
Aug 2013–Jul 2014	0.25%
Aug 2014–Jul 2015	0.50%
Aug 2015–Jul 2016	0.75%
Aug 2016–Jul 2017	1.00%
Aug 2017–Jul 2018	1.25%
Aug 2018–Jul 2019	1.50%
Aug 2019–Jul 2020	1.75%
Aug 2020–Jul 2021	2.00%
Aug 2021–Jul 2022	2.25%
Aug 2022 and thereafter	2.50%

Source: Deal documents

principal is not locked out from mezzanine bonds entirely. Principal should generally be paid *pro rata* between the senior and the subs. However, within the subs, principal is paid sequentially, with M1 receiving principal first. Additionally, there are triggers that allow unscheduled principal to be redirected away from the subs. For both STACR and CAS, the senior bond credit enhancement must meet its target before subs receive any unscheduled principal. As losses come in and erode the balance of subordinate bonds, the credit enhancement will fall below this threshold. At that point, the unscheduled principal will be redirected to the senior tranche until the enhancement returns above the target level. Unlike the CAS deal, STACR has a cumulative default trigger. The trigger is hit if cumulative credit events rise rapidly, ahead of a predetermined schedule of 0.25% per year (see Table 10.2). In this second trigger, unscheduled principal is again redirected to the senior class. In extreme scenarios, mezzanine bonds could receive very little principal.

As stated before, the bonds have a 10-year maturity, at which point all remaining principal is paid out to investors. Additionally, the bonds could be called early if the balance falls below 10%.

The size of the mezzanine bonds and first-loss pieces varies from deal to deal. Starting in 2014, Freddie Mac offered the newer deals with three mezzanine tranches to provide different duration and credit risk options to the investors. In 2015, Freddie Mac also started to offer the first-loss piece, B, to the investors. Additionally, the last cash flow mezzanine tranches also received BB ratings.

Freddie Mac introduced the first actual loss deal in 2015. In the actual loss deal, the loss only occurs when the loan is liquidated and the deal will no longer use scheduled severity. The final legal maturity of the actual loss deal is extended to 12.5 years with the redemption option at the end of ten years due to the longer timeline of realizing losses. STACR has also introduced a delinquency trigger along with the cumulative credit event trigger in their actual loss deal because the deal won't realize much actual loss for the first two years. The delinquency trigger can protect the senior note if the performance starts to deteriorate quickly before serious delinquent loans are being liquidated.

Supply and Investor Demand

The issuance of GSE CRT bonds grew from \$2 billion in 2013 to \$13 billion in 2014. For 2015, the two agencies issued \$13 billion altogether. As a part of the mandate for Fannie and Freddie to transfer the credit risk, the issuance will maintain a steady pace. The overall market size will reach close to \$100 billion in a few years.

GSEs' CRT notes have attracted various investors into the sectors (see Figures 10.2 and 10.3). Given the value profile, money managers are the biggest investors in senior mezzanine notes while both hedge funds and money managers are active in the lower credit notes. Hedge funds are the largest investors for the first-loss pieces. Banks are unlikely to be big buyers because the capital charges on these bonds are high.

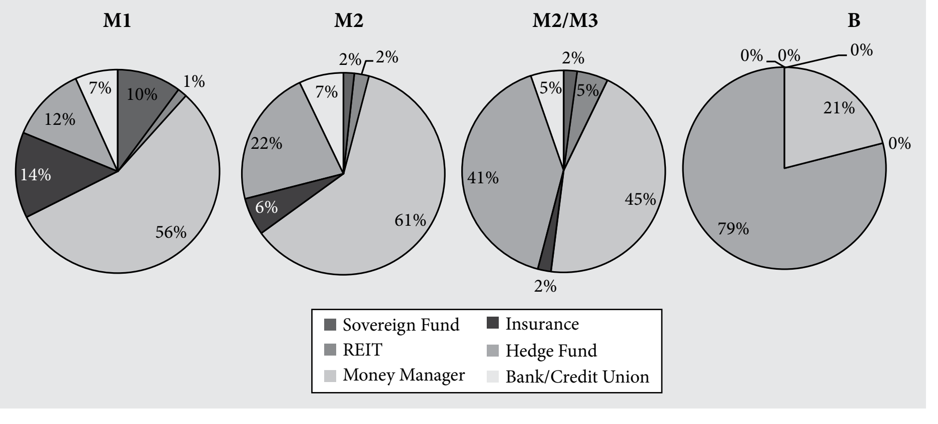

FIGURE 10.2 STACR investors

Source: Freddie Mac

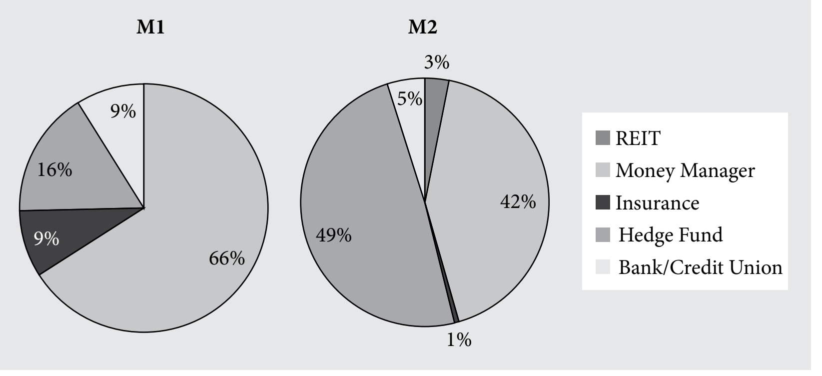

FIGURE 10.3 CAS investors

Source: Fannie Mae

As STACR/CAS bonds are structured as unsecured debts of the GSEs, REITs do not receive favored tax treatment. Hence, they have limited capital available to participate in these transactions.

Deal Analysis

To determine the default risk of the tranches, we can use historical data provided by both agencies and build a transition model. Figures 10.4 and 10.5 show cumulative defaults by origination year, FICO bucket, and LTV. Historical performance of cohorts with LTVs between 80% and 95% has varied significantly by credit score and vintage. The 2007 vintage had the highest cumulative defaults, while the default rates for the 2000–3 vintages are low, and would result in zero losses to any of the mezzanine CRT notes. There was a significant tightening in the underwriting standards after 2008. We can use the historical defaults on loans originated between 1999 and 2007 with similar characteristics to loans in the CRT deals to estimate the cumulative defaults under different home price appreciation scenarios. Each loan of the CRT deals will be mapped to similar loans in the historical data set and a default value is assigned based on how the historical loans performed under different housing scenarios.

Besides borrowers' characteristics, there are three major factors that also drive deal performance: underwriting, home price appreciation, and mortgage rates. In the recent underwriting environment, mortgage credit has only been available to pristine borrowers, which has significantly reduced the default risk. With strong home price appreciation, borrowers can accumulate a decent equity in the property which leads to cash-out prepayment. Higher prepayment because of the lower mortgage rates or cash-out refinance causes the deal to factor down faster and deleverage before the downturn. Hence, the cumulative default will be lower during the downturn.

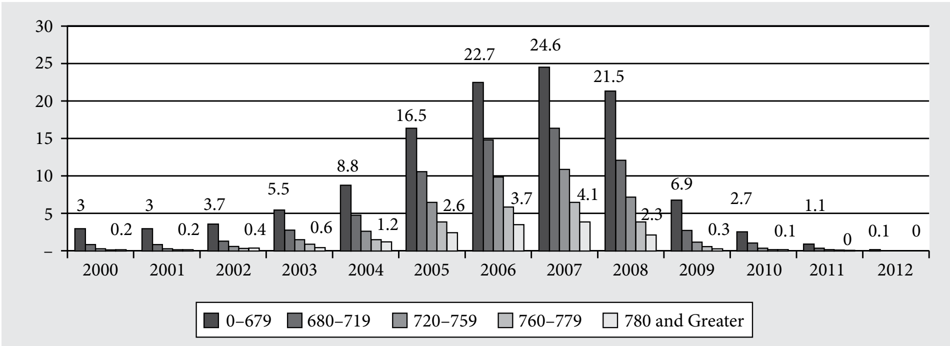

FIGURE 10.4 DN series: Historical cohort performance

Source: Freddie Mac

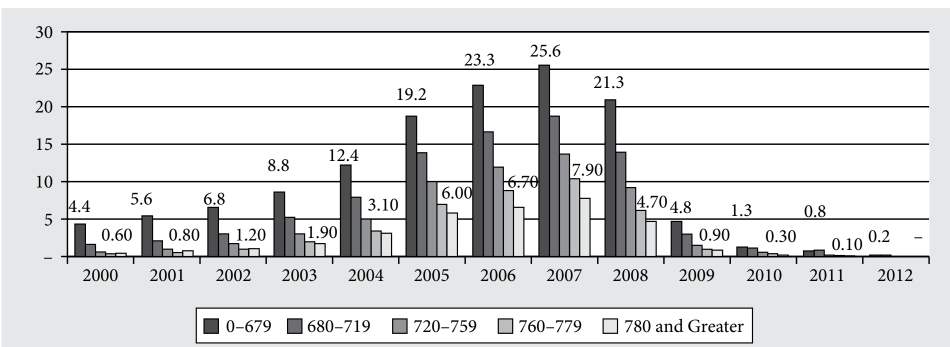

FIGURE 10.5 HQ series: Historical cohort performance

Source: Freddie Mac

Another concern with buying CRT bonds is the prepayment risk, given that many bonds are trading at premium. The first-pay tranches are the most sensitive to near-term speed moves with the magnitude dependent on the underlying collateral WAC and vintage, and whether the bonds trade at a premium or at a discount. Unrated tranches are relatively insensitive to changes in prepayment speed. The voluntary prepayments are driven largely by loan size, credit scores, current LTV, and rate incentive. Credit availability has a substantial impact on the voluntary prepayment speed as well.

Deal Performance

Figures 10.6 and 10.7 highlight 30+-day delinquencies for each outstanding STACR and CAS deal. The high LTV deals have ramped faster and have larger delinquency buckets. Default (credit event) rates remain low, with most deals below 0.07% CDR.

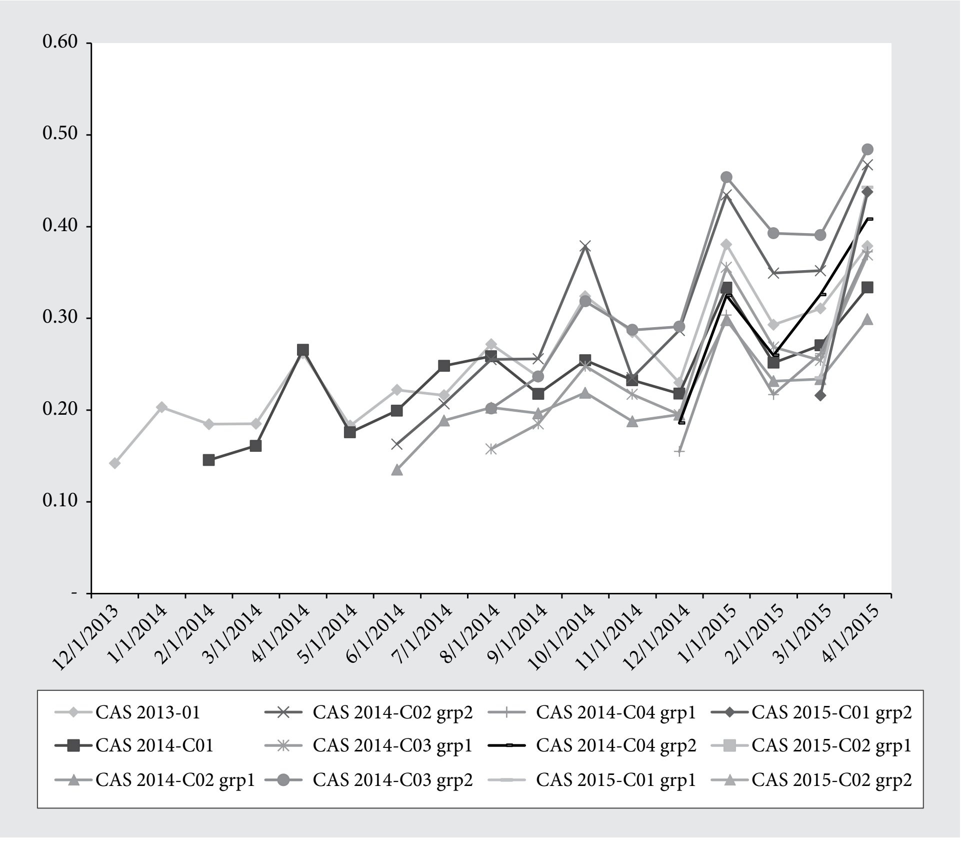

FIGURE 10.6 CAS 30+ delinquency

Source: Trustee and Fannie Mae

Voluntary prepayment speeds on GSE CRT bonds, Figures 10.8 and 10.9, were muted in 2014 with most deals exhibiting middle single-digit prepayment speed.[1] Given the rate rally in January 2015, higher weighted-average coupon and less seasoned STACR deals posted strong prepayment speeds in March and April. On average, owner-occupied borrowers as well as the loans in nonjudicial states tend to prepay faster.

Secondary Trading Activity

Since these securities are considered as agency debts, they are all reported on the TRACE system through FINRA. Most dealers are supporting the programs and provide the liquidity in the secondary market. One challenge hindering the liquidity of the sector remains

[1] The measure used for prepayment speed is the conditional prepayment rate (CPR).

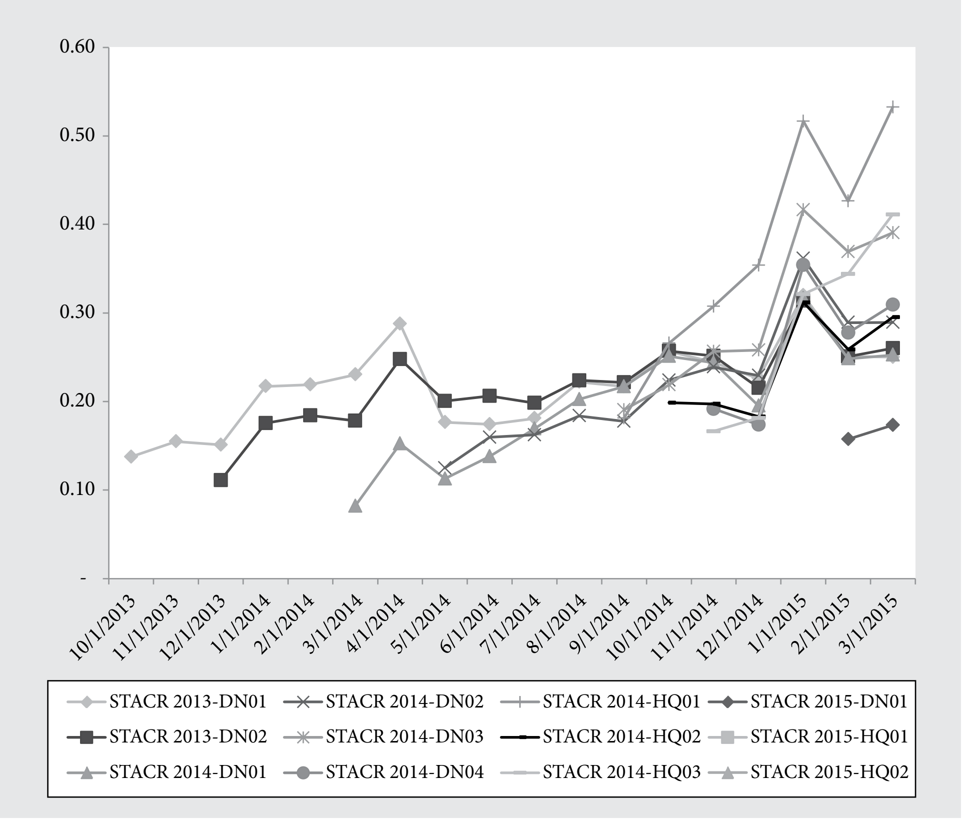

FIGURE 10.7 STACR 30+ delinquency

Source: Trustee and Freddie Mac

on the regulatory side. With dollar-for-dollar capital charges for all tranches, dealers are less incentivized to hold inventory and support the market while liquidity is thin. This is especially a concern for this market compared with other securitized products.

Repo refinancing availability can also play an important role in demand. Hedge fund investors have dominated in lower tranches and some of them are using leverage to enhance the return. They may be forced to sell securities or take profit if the financing term is no longer available or attractive. The spread may widen out if there are no end buyers or if the dealers cannot hold big positions due to the capital charge.

Risk and Future

Following the success of the Freddie Mac first-loss notes, since spreads of the notes have tightened in significantly, we are likely to see more first-loss pieces being sold. Fannie Mae has followed suit in issuing first-loss pieces in 2016. Another change in the sector is

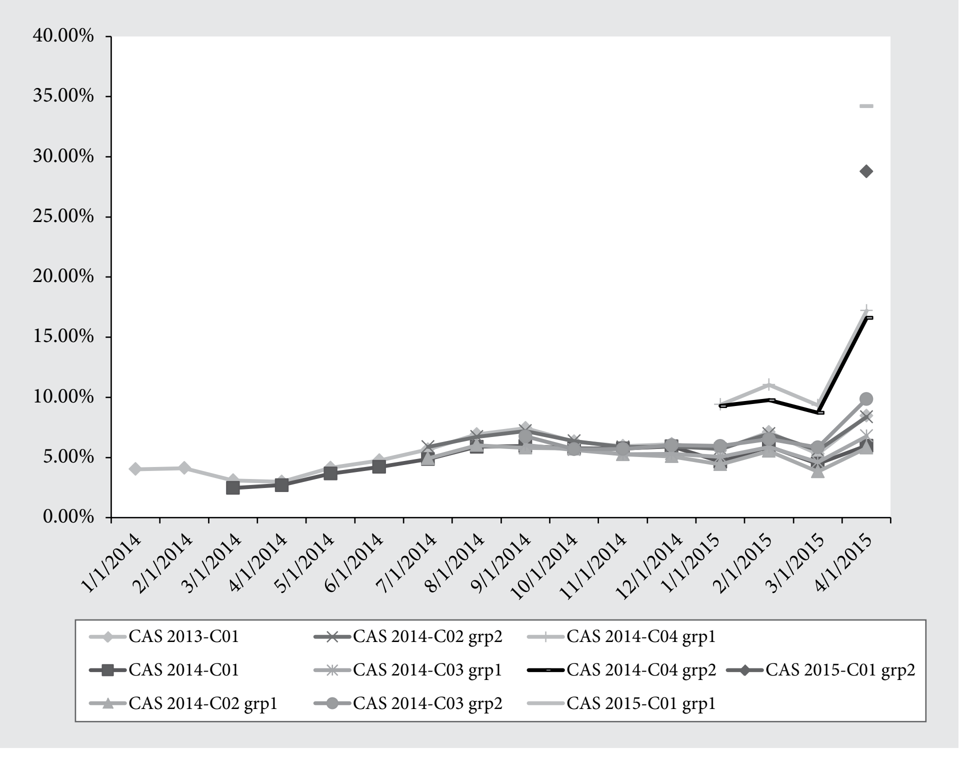

FIGURE 10.8 CAS one-month prepayment rate (CPR)

Source: Trustee and Fannie Mae

that we are expecting more actual loss transactions. A draft of a financial reform bill has called for increasing usage of first-loss and front-end risk-sharing transactions, where the risk is sold prior to the guarantee. If the bill is enacted, it will increase the volume of risk-sharing transactions. However, this bill is still a long way from becoming a law. Based on investor demand and the FHFA mandate, we envisage this program will continue to grow.

Key Points

- Credit risk transfer bonds are debt securities from Fannie Mae and Freddie Mac.
- Principal and interest payments of credit risk transfer bonds are linked to a reference pool of assets.
- The collateral for credit risk transfer bonds consists of 30-year amortizing fixed-rate loans originated post-crisis with the loan-to-value ratios falling in a certain range.
- High LTV deals come with mortgage insurance and higher subordination to offset the higher default risk.

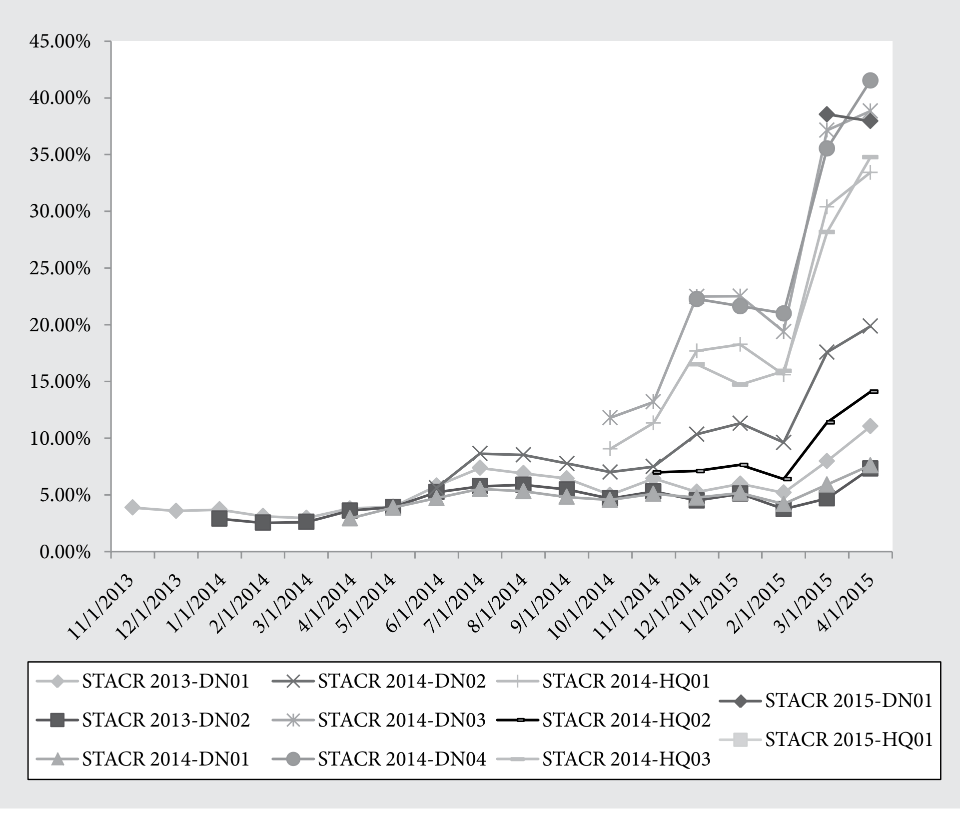

FIGURE 10.9 STACR one-month prepayment rate (CPR)

Source: Trustee and Freddie Mac

- The default definition is different from traditional RMBS and most deals use a fixed loss severity schedule.
- The delinquency rate and liquidation rate remain low on these deals because of tight underwriting in recent years.
- Money managers and hedge funds have been the dominant investors, while banks find the sector less attractive because of the steep capital charges.

CHAPTER 11

AGENCY MORTGAGE-BACKED SECURITIES

Performance, Valuation, and Risk Premium Comparatives

ION DAN AND PHILIP O. OBAZEE

AFTER reading this chapter you will understand:

- the relative risk and return characteristics of agency mortgage-backed securities compared to other fixed-income securities and the broad equity market benchmark;
- the risk associated with investing in agency MBS;
- the complexities associated with replicating the returns of the Barclays MBS Index;
- the difficult task of modeling prepayment behavior;
- popular MBS valuations methodologies.

In this chapter we review the historical performance of agency mortgaged-backed securities (MBS). Our review reveals that over time, this asset class has delivered an attractive risk–reward profile compared to other high-grade fixed-income sectors. The results hold across multiple market environments, including stress scenarios such as the financial crises of 2008–9. The liquidity and yield advantage of agency MBS are key features behind the performance, while the inherent prepayment risk makes their analysis particularly complicated. The complexity of prepayment modeling makes analyzing this sector a task of balancing science with art, which materially leads to some market inefficiencies. We also cover some topics on prepayment modeling and valuation approaches with a focus on concept and practical application.

Agency MBS Returns: A Historical Perspective

Some of the basic questions that market participants generally ask relate to the historical performance of a particular asset class. Thus, we begin by addressing this question: is it profitable to invest in agency MBS over long horizons or is the asset class "opportunistic"? If this asset class is opportunistic, should investors then focus on correctly timing the periods of favorable performance?

To address this question, we analyzed the data set of monthly Barclays Index returns from January 1990 to December 2014 for MBS, intermediate Treasuries, and investment-grade corporate bonds. Performance statistics were also calculated for the Intermediate Aggregate and the S&P 500 for comparison purposes. Although the choice of intermediate maturity sectors was arbitrary, we note that historically these maturity buckets have more closely matched the duration of the US MBS index.

Table 11.1 summarizes the results of our performance analysis and it shows:

- From a downside protection standpoint, MBS had the least number of negative quarters, and the magnitude of loss during those periods (also known as "drawdowns") compares favorably.
- MBS delivered superior returns compared to Treasuries and better risk-adjusted returns compared to corporate bonds.

Standard risk/reward measures such as the Sharpe ratio and skewness of MBS returns are particularly attractive. Sharpe ratio is a risk-to-reward measure of the outperformance (excess return) of an asset versus a "risk-free" investment, such as T-bills, adjusted for the extra volatility that an investor endures for holding the riskier asset (the standard deviation of the excess return).

Additional analysis of data from 1990–2014 sourced from Delaware Investments and Barclays highlights the diversification benefits of agency MBS. Over the period we analyzed, MBS returns have been most correlated to intermediate Treasuries (0.86), and as expected least correlated to equities (0.09). The correlation with intermediate corporates over this same time period was 0.7.

Over longer horizons, yield and duration are the major drivers of total return in the fixed-income market. Relatively adjusting yields, in our fixed-income analytical universe, in terms of durations and the volatility of yields as shown in Table 11.2, tell an excellent story about the performance characteristics of agency MBS relative to other investment-grade sectors.

The liquidity and market size of agency MBS are only rivalled by that of Treasuries, and this can be gleaned from Table 11.3. The issue of liquidity has become very prominent in the fixed-income market since the global financial crisis, as the evolving regulatory regime has created capital and balance sheet constraints for dealers.

It is instructive to analyze how the historical performance statistics hold up over shorter time horizons. Figure 11.1 provides a glimpse into the distribution of annual returns for

Table 11.1 Historical performance of Barclays US MBS Index relative to other markets

	Int Agg	MBS	Int IG	Int Treas	S&P 500
Number of quarters with negative returns	17	**15**	21	29	29
Lowest quarterly return	−2.10%	**−2.32%**	−7.04%	−2.34%	−21.95%
Average return of negative quarters	−0.71%	**−0.65%**	−1.17%	−0.69%	−6.96%
Lowest quarterly return in stress scenarios					
1994	−2.10%	−2.32%	−2.73%	−1.86%	−3.78%
1997	−0.02%	0.13%	−0.41%	−0.07%	2.69%
2003	0.18%	0.51%	0.16%	−0.26%	−3.14%
2008	−0.96%	−0.49%	−7.04%	−2.07%	−21.95%
2013	−1.78%	−1.96%	−2.38%	−1.42%	2.91%
Average quarterly return	1.52%	1.58%	1.67%	1.39%	2.64%
Average annualized return	6.15%	6.43%	6.76%	5.60%	9.60%
Standard deviation	2.94%	2.92%	4.26%	3.12%	14.62%
Risk-adjusted annual return	2.09	**2.20**	1.59	1.80	0.66
Average return over 3-month T- bills	2.78%	3.05%	3.37%	2.25%	6.12%
Standard deviation	2.86%	2.83%	4.26%	3.00%	14.64%
Sharpe ratio	0.97	**1.08**	0.79	0.75	0.42
Skewness	−0.26	**−0.13**	−0.91	0.02	−0.63

Source: Authors' calculation based on data obtained from Delaware Investments and Barclays. Monthly index data from 1990–2014

Table 11.2 Key risk and return characteristic of agency MBS to intermediate Treasury and corporate bonds

	Average yield	Yield standard deviation	Average duration	Yield/stdev	Yield/dur
US Mortgage-Backed Securities	5.85	1.94	3.40	3.02	1.72
US Treasury: Intermediate	3.70	2.03	3.45	1.82	1.07
Intermediate Corporate	4.70	1.69	4.38	2.78	1.07

Source: Authors' calculations based on data obtained from Delaware Investments and Barclays. Monthly index data from 1990–2014

MBS, Treasuries, and corporate bonds. At first glance, the distribution of MBS returns compares closely to that of Treasuries (heavy solid line versus lighter solid line); however, the returns of MBS are generally above those of Treasuries. There were two important deviations in returns between MBS and Treasuries, one going into the 2008 financial crisis when MBS decoupled from Treasuries, and a second coming out of the crisis, as the Federal Reserve supported the MBS market during the first round of quantitative easing purchases.

Table 11.3 Agency MBS market size and liquidity

	US MBS	IG Corp	Treasury
Market size			
Market value (MM)	5,069,611	4,097,111	6,307,840
% US Aggregate	29%	23%	36%
Number of issues	404	5201	253
Average daily trading volume ($B)			
2014	178	27	505
Last 5 years average	249	23	533
Last 10 years average	272	20	528

Source: Authors' calculations based on data from Barclays (index data as of December 31, 2014) and Securities Industry Financial Markets Association (SIFMA)

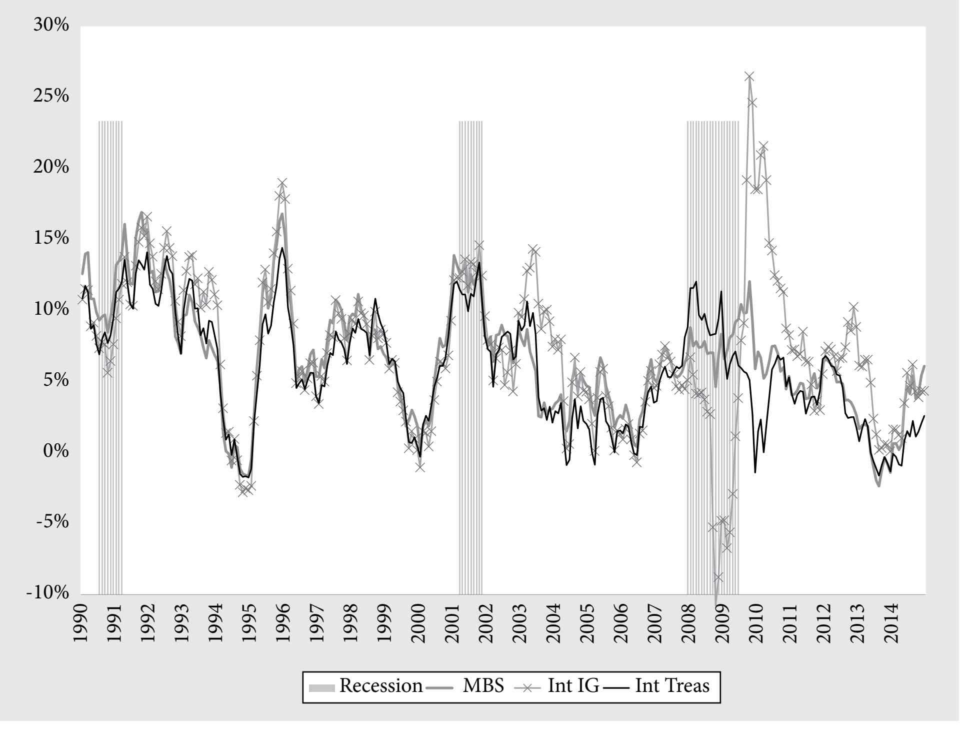

FIGURE 11.1 Twelve-month rolling returns, 1990–2014

Source: Authors' calculation based on data from Barclays. Monthly index data from 1990–2014

On the other hand, corporate bonds (line with x marker in Figure 11.1) have a wider distribution of returns with fatter tails, which is more closely related to the business cycle. Generally, corporate bonds outperform in the recovery phase and underperform during downturns.

The performance during risk periods is mixed. In 1994, all fixed-income sectors dipped below zero on an annual basis. In that scenario, referring back to Table 11.1, on a quarterly basis MBS underperformed Treasuries but outperformed corporate bonds. During the 1997 Asian financial crisis, US investment-grade sectors escaped the turmoil. In 2003 when the MBS market experienced massive refinancing activity, the asset class marginally underperformed Treasuries but corporate bonds had better relative performance. On an absolute basis, however, as shown in Table 11.1, quarterly returns for MBS remained positive in 2003. During the 2013 "taper-tantrum," both MBS and Treasuries led on the way down, as expectations about quantitative easing purchases in both asset classes were altered by the Federal Reserve.

Let's now focus on the performance (i.e., alpha) of agency MBS relative to Treasuries and investment-grade corporate bonds. Figure 11.2 shows the one-year (12-month rolling represented by the light solid line) and 3-year (36-month rolling represented by the heavy solid line) alpha (annualized difference of monthly returns) for MBS versus Treasuries, while Figure 11.3 shows similar rolling returns for MBS versus corporate bonds.

Table 11.4 provides summary statistics. The data suggest that the alpha potential, although positive, is low relative to its standard deviation over 12-month rolling horizons. This leads to a low information ratio (average alpha/standard deviation). Generally, information ratios above 0.50 are desirable as a stability of outperformance measure. However, even on the shorter horizon, the good/bad skew is impressive—204 months of positive alpha versus 96 months of negative alpha, and the average alpha of positive months exceeds that of negative months.

If the investment horizon is extended, both the information ratio and the good/bad skew improve significantly. In fact, since 1990, using a 36-month rolling investment horizon, MBS have outperformed Treasuries 86% of the time. On the other hand, there is no clear indication of strategic alpha in MBS versus corporate bonds.

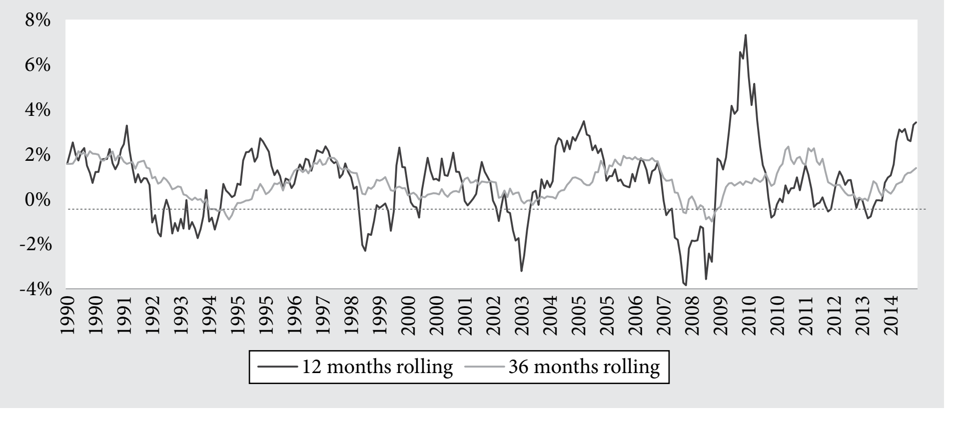

FIGURE 11.2 MBS performance relative to Treasuries

Source: Authors' calculation based on data from Barclays. Monthly index data from 1990–2014

Table 11.4 Summary statistics for MBS performance relative to Treasuries

	12-month rolling	36-month rolling
Number of months	300	300
Negative alpha months	96	43
Positive alpha months	204	257
Underperform	32%	14%
Outperform	68%	86%
Average alpha of negative months	−1.00%	−0.31%
Average alpha of positive months	1.60%	0.96%
Average alpha	0.77%	0.77%
Standard deviation	1.61%	0.74%
Alpha/standard deviation	0.47	1.05

Source: Authors' calculation based on data from Barclays. Monthly index data from 1990–2014

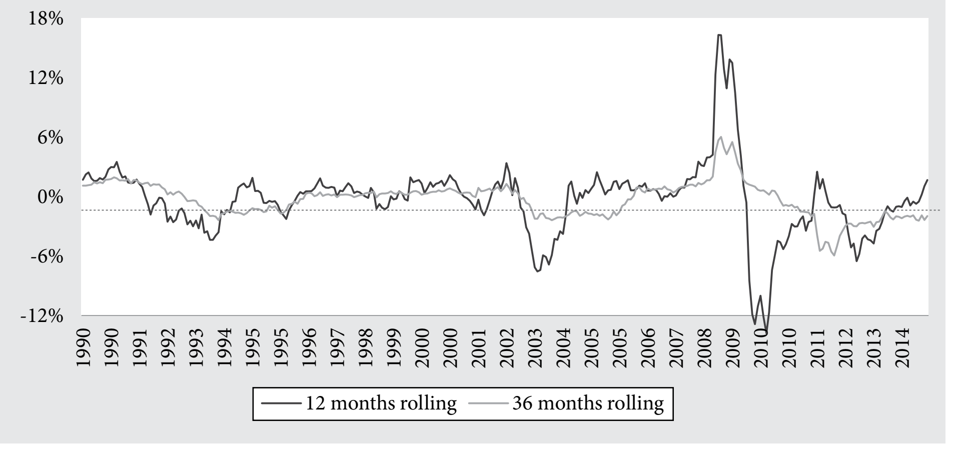

FIGURE 11.3 No strategic alpha between MBS and corporate bonds

Source: Authors' calculation based on data from Barclays. Monthly index data from 1990–2014

The occurrence of positive and negative returns is marginally skewed in favor of MBS (Table 11.5). In general, MBS underperforms corporates in the recovery phase of the business cycle but outperforms late-cycle. As such, opportunistic sector rotation is a key performance driver. However, the historical alpha profiles support the argument for combining MBS and credit portfolios for enhanced diversification and risk-adjusted returns.

Table 11.5 Summary statistics for MBS performance relative to corporate bonds

	12-month rolling	36-month rolling
Number of months	300	300
Negative alpha months	145	140
Positive alpha months	155	160
Underperform	48%	47%
Outperform	52%	53%
Average alpha of negative months	−2.77%	−1.79%
Average alpha of positive months	1.93%	1.00%
Average alpha	−0.34%	−0.30%
Standard deviation	3.70%	1.77%
Alpha/standard deviation	−0.09	−0.17

Source: Authors' calculation based on data from Barclays. Monthly index data from 1990–2014

Risks Associated with Agency Mortgage Investments

Viewed from the concept of equivalent risk class in terms of credit rating, efficient market theory would suggest investors should obtain the same long-term return from either holding a portfolio of agency mortgages or Treasuries. That would be true if structurally there is no optionality in an agency mortgage that come from prepayment risk, which affects its cash flow characteristics. One way to think about this risk is that the MBS investor has sold a call option to a pool of borrowers. The standard conforming mortgage allows borrowers to prepay the principal in full or in part at any time over the term of the loan (typically 30 years). Thus a 30-year mortgage might only have a term of one year. An investor who buys an agency MBS is buying a security with an uncertain maturity. At any time, there is a natural level of mortgage prepayments that occur when a house is sold. This can occur voluntarily when, for example, a mortgage borrower sells their house to buy a new one, or involuntarily when the mortgagee cannot meet their repayments and their house is repossessed and sold. Macroeconomic factors such as house prices, employment, underwriting standards, and government policy impact borrower prepayment behavior, and loan characteristics differentiate the impact of such factors.

However, the level of prepayments is also dependent on the direction of interest rates. Variation in interest rates is the most important source of uncertainty related to prepayments. For example, if a mortgagee has a loan at a 5% interest rate and mortgage rates drop to 4% then they can repay their original loan and take out a new loan at the lower rate with no penalty. An MBS will thus suffer an increase in prepayments as interest rates drop, and conversely a lessening in prepayments as interest rates rise. At a more technical level, this means that the duration of MBS generally change in the same direction as the change in interest rates. This has a magnifying effect on the securities price relative to a fixed-rate bond with the same coupon and fixed duration. This is termed "negative convexity." The prepayment risk and negative convexity are reflected in the spread compensation (higher yield) of MBS.

The historical performance analysis of MBS alpha relative to Treasuries indicates that this option premium must be higher than is required over the long term. So the answer to the question why do MBS outperform Treasuries can be rephrased as why is the underlying call option that the MBS investor sold mispriced?

Although option pricing theory has advanced considerably since Black and Scholes produced their seminal work in the early 1970s, there are many options that are difficult

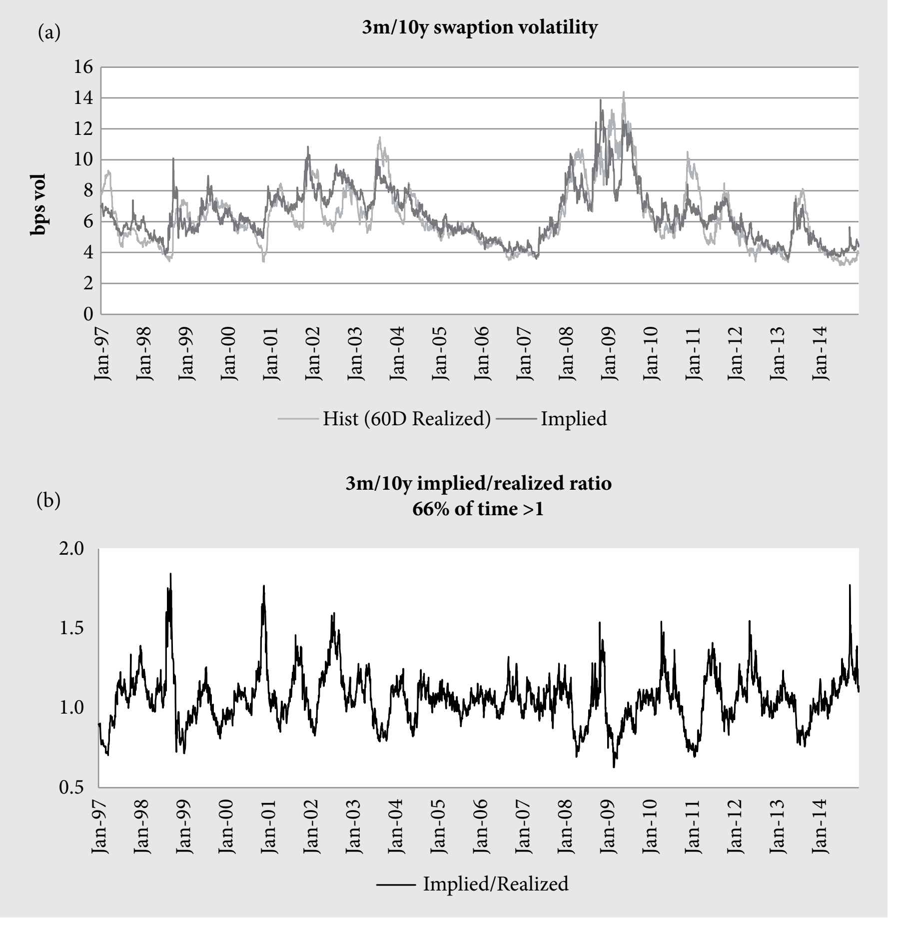

FIGURE 11.4 Implied volatility premium occurs 66% of the time

Source: Author-constructed figure from Delaware Investments data, using daily closing levels from 1997–2014 to price. In order to correctly price the MBS option, one needs a reliable prepayment model and interest rate model (and the two are interconnected). Both problems are difficult and different market participants have different models (leading to different prices). The inherent uncertainty in pricing this option means that investors demand a premium higher than necessary to participate in the market.

It is also interesting to observe option pricing in interest rate markets. The basic idea here is that an agency MBS behaves approximately like an equivalent duration rate benchmark plus a sold call option. Thus, any mispricing in Treasury or LIBOR call options flows through into MBS.

Figure 11.4 shows implied and actual volatility for a 3-month/10-year swaption. Implied volatility is the market forecast of what the underlying instrument's realized volatility will be. For 3-month/10-year swap rates (10-year LIBOR rates, three months forward), implied volatility quotes are available from Delaware Investments from 1997. Panel (a) shows implied (traded) swaption volatility (heavy solid line) and realized volatility of the underlying LIBOR rate on a 60-day rolling basis (light solid line). Panel (b) shows the ratio of the two measures and highlights that implied volatility tends to be greater than actual volatility 66% of the time. This means there are better than even odds that the option component in the valuation of an MBS security is usually overpriced. So it is not surprising to observe MBS outperform over time, especially under a longer investment horizon, where the yield advantage accrues and compounds relative to Treasuries.

Agency MBS Index, Replication, and Exchange-Traded Funds

Investors who want exposure to the agency MBS market can do so through passive (index replication) strategies or through active managers who specialize in the asset class. However, unlike other markets, the passive approach is not a trivial exercise, and requires a depth of market knowledge.

Unlike other indices, Barclay's MBS Index contains over 400 nontraded aggregates. Similar methodologies apply in the construction of Merrill and Citigroup MBS indices. These index generics are composites of tradable MBS securities (pools) defined by three characteristics:

1. agency/program (e.g. FN/FH/GN 30-year or 15-year conventional);
2. origination year of underlying mortgages (e.g. 2008);
3. coupon (e.g. 5.5%).

Most index replication frameworks screen the index population to find a small subset that will most closely track the index (optimize a subset for tracking error). The investor can then buy this subset with the expectation that its performance will mirror, with some degree of error, the performance of the overall index. This process is followed by ongoing monitoring of tracking error and rebalancing of portfolio holdings. There are two basic methods of replicating the performance of an agency MBS index: an investor can buy either specific pools or TBA (to-be-announced) contracts.

Pool replication has its pros and cons. Tracking error is generally minimized because specific seasoning buckets are targeted. However, implementation is difficult and requires detailed knowledge of the market. There is a large population of "a-like" pools to choose from, and even when the investor tries to control for the same basic characteristics as those used for index construction, there is no assurance that a selected pool will perform identically to the index generic. Differences in underlying borrower attributes may lead to differences in the timing of a particular pool's cash flow, which will result in tracking error. Examples include WAC (weighted-average borrowing rate/coupon of underlying loans), loan size (smaller loans are less likely to be refinanced than larger loans because of sunk costs involved in the process), geographic concentration (one part of the country may experience faster housing turnover than another), LTV ratio (loan-to-value), FICO distributions, and originator/servicer distributions.

Consider the following two 30-year FN 5.5% pools (FN 984689 and FN 982642), both originated in 2008, and their respective index generic. Even though prices for the three securities will be identical over the holding period, differences in prepayments (as measured in terms of conditional prepayment rates, CPRs) will lead to differences in total returns. From a cash flow perspective, the buyer of an MBS pool is entitled to the monthly interest and principal paydowns. However, the magnitude of these payments depends on the prepayment pattern of individual mortgages underlying the pool, which can be significantly different even for similar types of borrowers, leading to different total return performance.

Tracking error from replication of more illiquid coupons such as seasoned high premiums will generally be much greater and also more difficult to implement. Table 11.6 illustrates that small underlying borrower differences, such as loan size or geographic distributions, can lead to different prepayment behavior.

Table 11.6 Comparison of 30-year FN 5.5% vs index generic

Pool/Index generic	Pool: FN 984689	Pool: FN 982642	Index generic FNA05408
Coupon	5.50	5.50	5.50
WAC	5.91	5.91	6.01
WALA	13	14	12
Average loan size	290K	214K	N/A
Geographic distribution	52%CA; 6%NY	100%TX	N/A
3mo CPR	22.8	30.5	30.4
6mo CPR	21.4	30.0	25.9
Total return (Dec 08–Jun 09)	2.62	2.52	2.58

Source: Table constructed from Delaware Investments and Barclays data

Instead of buying a pool, an investor can use TBAs, but the performance of these securities may also differ from that of their respective index generic. A TBA transaction is a forward contract to buy MBS pools of a given agency/program and coupon. The TBA buyer will not know what specific pool(s) he will get delivered until two days before settlement. No cash outlay is required until settlement and the buyer has the option to "roll" TBAs month-to-month, avoid delivery, and invest cash in short-term alternatives. However, TBA prices trade to cheapest-to-deliver assumptions. The TBA seller also has an option to deliver any mortgage pool(s) to satisfy a contract delivery, and will likely deliver the least attractive pools he can find (fast-paying premiums and slow-paying discounts). This is reflected in TBA prices. By making what are really unique and often small pools interchangeable, the TBA market facilitates forward trading and overall agency MBS market liquidity, and provides a means for fluidity in the housing finance channel by allowing mortgage lenders to more efficiently manage risk and "lock in" sale prices for new loans, as or before those mortgages are originated.

This liquidity feature flows through into strategies that use TBAs for replication. Furthermore, the TBA feature simplifies back-office operations because it avoids taking physical delivery. However, the index tracking error can be significant because of different origination years of the pool aggregates comprising the Barclays MBS universe. As a replication strategy, a TBA-only strategy can minimize tracking error only for the seasoning bucket that the market "thinks" will represent cheapest-to-deliver for a particular coupon. Generally, TBA replication works well for the recently originated part of the MBS market, but has considerable tracking error for the more seasoned portion.

In Chapter 30, covering the replication of MBS indexes using TBAs, Nikki Stefanelli and Bruce Phelps present REMIX as an optimized TBA replication of the Barclays US MBS Index. As noted by the authors, while the average monthly tracking error of this replication strategy has been small, Table 11.7 suggests that there have been months when the tracking error has been significant. Additionally, the skew (a characterization of the degree of asymmetry of distribution around its mean) is negative, suggesting tracking errors have occurred with a negative bias. Comparing the returns of various

Table 11.7 Relative performance of REMIX versus Barclays US MBS index (in bps)

Replication strategy	REMIX
Average tracking error	0.3
Minimum	−54.0
Maximum	27.0
Skew	−1.8
Average tracking error annualized	3.4

Source: Summary of tracking Figure 1 from Chapter 30: REMIX realized monthly tracking errors, September 2001–April 2015.

Table 11.8 Some characteristics of mortgage-backed exchange-traded funds

Ticker	Description	Benchmark	Provider	Inception	AUM	Expense ratio
MBB	Full replication	Barclays US MBS	Blackrock iShares	3/13/2007	6.65B	0.27%
VMBS	Full replication	Barclays US MBS	Vanguard	11/19/2009	1.36B	0.12%
MBG	Optimized replication	Float-adjusted Barclays US MBS	State Street SPDR	1/15/2009	152.00M	0.29%

Source: Table constructed from data available on providers' websites

exchange-traded funds (ETFs) that intend to mimic the result of the Barclays US MBS Index further highlights the complexities of replication.

As of the end of 2014, there were six MBS ETF options available in the marketplace. Two of them—MBSD and LMBS—were newly issued and had limited history. The GNMA iShares tracked only a subsector of the MBS universe. The remaining three, MBB, VMBS, and MBG, are shown in Table 11.8.

Different providers use different kinds of optimization technology and the tracking error can be substantial according to the following data from Delaware Investments:

Tracking error	MBB	MBG	VMBS
1 year	0.572	0.957	0.424
3 years	0.502	0.746	0.493
5 years	0.447	1.311	0.590

Assessing the Risk/Reward of Agency MBS

Two relative valuation measures commonly used by MBS investors are the option-adjusted spread (OAS) and nominal spread or yield advantage over a similar duration security. These measures are described in more detail in Chapter 24. Here we provide a brief discussion of the two measures.

In contrast to the simple yield curve spread measurement of bond premium for a fixed-maturity cash flow (bullet) security, OAS describes the market premium for embedded optionality.

It is defined as the spread value that equates the market price of an MBS security to its value in a theoretical framework—projected future cash flows discounted at projected future yields. The OAS method separately values the call option and noncallable coupon bond components of the MBS. Under this methodology, the value of the call is the option cost, defined as the additional basis yield spread.

OAS modeling includes two types of volatility: interest rates and prepayment rates. Designing such models is difficult but more importantly it is not homogenous across the industry because the prepayment function is a behavioral response to movement in interest rates, which opens the door to different approaches. Moreover, there are various approaches to simulating the volatility of future interest rates and the shape of forward curves. Hence, OAS valuations are not homogenous across different providers.

Prepayment modeling is a complex issue. There is a large variety of mortgage and market data available for study, including loan types, coupons, vintages, dollar balances, mortgage rates, shape of the yield curve, refinancing alternatives, prepayment costs, housing values, tax rates, regulation, government policy, and much more.

Prepayments may occur for one of several reasons: refinancing into a new mortgage with a lower interest rate; sale of property because of relocation or a move to a new house; defaults; partial prepayments of principal (curtailments); or homeowner motivations beyond rational (interest-rate-related) considerations, such as divorce or death, which also play an important role in borrower behavior.

As such, a prepayment function can be written as the sum of four submodels of homeowner prepayment decisions:

Refinancing + Relocations + Defaults + Curtailments

Prepayment functions are generally estimated by fitting actual prepayment speeds to various key variables, including level of interest rate in various products, refinancing costs (fees, upfront points), loan age, seasonal factors, and macroeconomic factors such as housing prices, aggregate incomes, underwriting standards and servicer industry trends, regulation, government policy, etc.

Prepayment models should consistently track absolute and relative prepayment rates (predicted vs actual). Models should achieve consistent results across various mortgage types, coupons, and vintages, and be robust in treating prepayment outliers.

In practice, prepayment models are less than perfect. Hence, MBS valuation based on OAS is always subject to prepayment model risk (the risk that prepayment projections are systematically biased). One known area of possible prepayment model risk is that borrowers usually do not or cannot optimize their right to exercise their prepayment options (it is a behavioral process).

Further, macroeconomic factors are not constant through time. Home prices and incomes are affected by the business cycle. Underwriting standards are not constant and consistent across different populations of borrowers. Additionally, the servicing industry has evolved.

For example, prior to the crisis, the servicing industry was fragmented, highly competitive, and lightly regulated. Since 2009, the industry has become more bifurcated, with the largest money-center banks that survived on the one hand, and the emergence

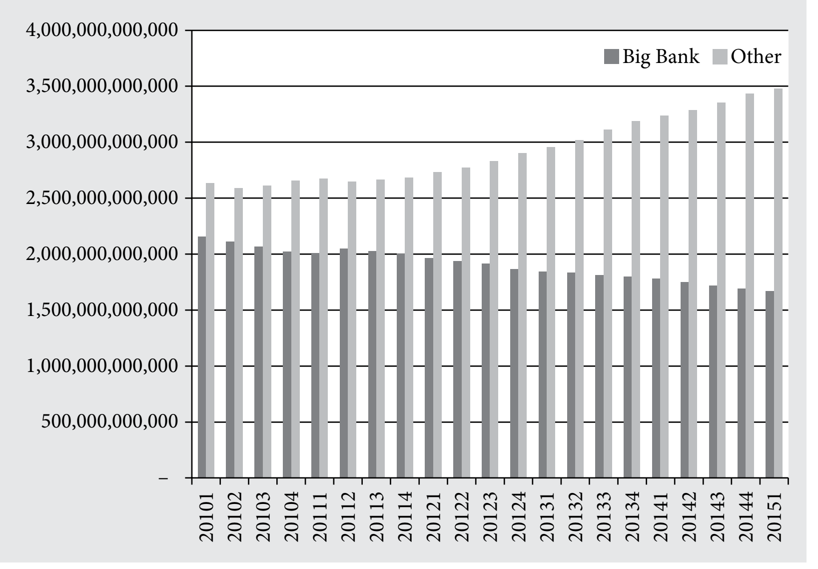

FIGURE 11.5 Servicing has shifted from big banks to smaller non-bank entities

of non-bank entities on the other hand. Some servicers have business models focusing on generating revenue by refinancing high volumes of borrowers as often as possible. Other servicers are less aggressive, concentrating instead on customer relationships, and may be more purchase-loan-driven. Large banks with more regulatory oversight may be less likely to pursue the former strategy, due to heightened awareness of regulatory scrutiny and put-back risk. Certain newer servicers also have highly performance-driven company cultures and are able to close loans more quickly and offer more attention to customers to increase market share. Newer, smaller shops may be more adept at incorporating recent technology that can automate much of the application and underwriting process, reducing capacity constraints. Others may develop relationships with appraisal and insurance companies to mitigate bottlenecks and reduce costs. These business decisions at the servicers' level impact prepayment behavior of the underlying mortgages; and these differences need to be addressed in prepayment modeling. Figure 11.5 highlights how recently big banks have been losing market share to smaller non-bank servicers.

Regulation and government intervention, especially following the financial crisis of 2008, have also played a key role in first removing nonperforming mortgage loans from existing securitized structures (which impacted prepayments), and later supporting the flow of mortgage credit in a safe and sound manner, while offering refinance opportunities for underwater (negative equity) borrowers that remained current with their payments. All these factors impacted prepayment behavior in different ways that did not have a historical equivalent, making modeling very difficult.

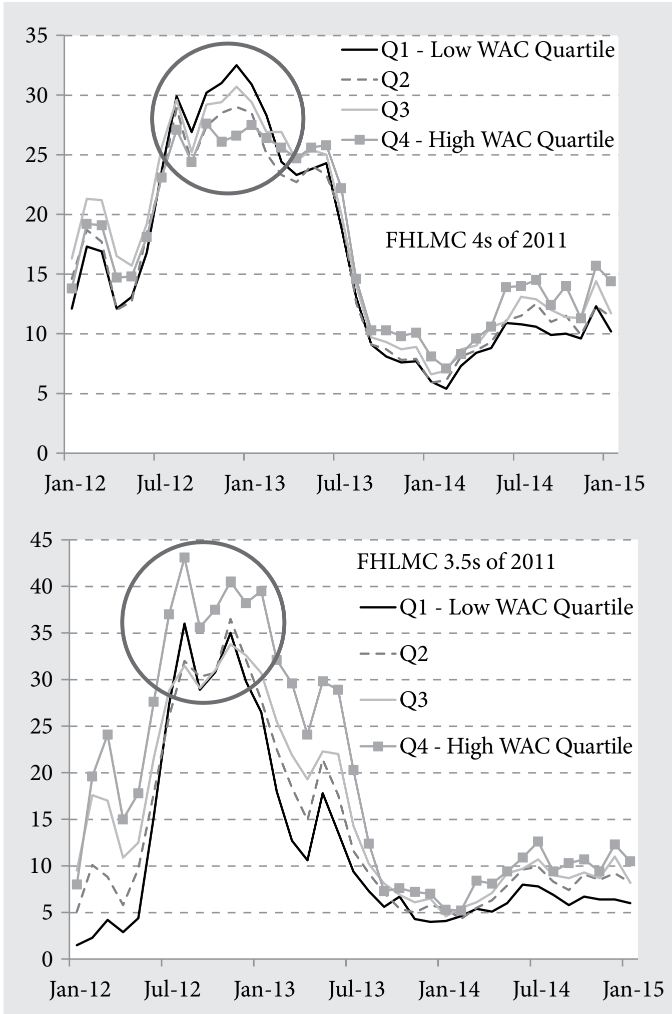

FIGURE 11.6 Certain collateral attributes may mean different things for different cohorts of borrowers in terms of prepayment behavior

Collateral attributes affect prepayments in a highly nonlinear fashion (think S-curve). Some attributes such as loan-to-value ratio (LTV), indicators of creditworthiness (FICO score), and debt-to-income ratios (DTI) have critical values which determine how difficult it can be for a borrower to refinance. The average value can be misleading. Creative solutions, such as using quartile values (or in the case of weight-average coupons or WACs, a full distribution of values using loan-level data), can improve results but methods of addressing these issues vary across different modeling approaches.

Figure 11.6 shows how the highest WAC quartile for borrowers prepaid for 3.5% and 4% FHLMC coupons. For 3.5s, the highest WAC quartile was the fastest. The trend was reversed for 4s, where peak speeds were the highest for lower WAC borrowers. The explanation is impairment. The higher WAC 4s generally had a higher spread (higher mortgage rate) at origination because of lower FICO scores and higher LTVs. The lesson from this is that higher WACs can imply higher incentive and higher speeds, but in some cases can include impairment and lower prepayment sensitivity.

Other factors that impact prepayment include loan size and age (months since origination). Figure 11.7 shows the effect of these prepayment sensitivity drivers. Higher loan sizes imply more cost saving from refinancing for a given rate level. While borrowers usually do not move after purchasing a new home, this affects their turnover/relocation function.

Housing seasonality also affects turnover, as can be seen from Figure 11.8. People tend to move more in late spring and summer than in the winter months (the effect of the school year).

Loans size, age, and seasonality are more commonly studied behavior trends but the approach to modeling all these factors can be different.

Figure 11.9 illustrates the OAS concept for current coupon mortgage spreads to the LIBOR curve. Note that the current coupon is a theoretical construct (yield on a par on-the-run coupon MBS), built from interpolation between two actual TBA (price, coupon) pairs that bracket par.

The figure shows that the overall direction is similar across models; however, indication of value is not consistent and the sensitivity of these estimates is not constant.

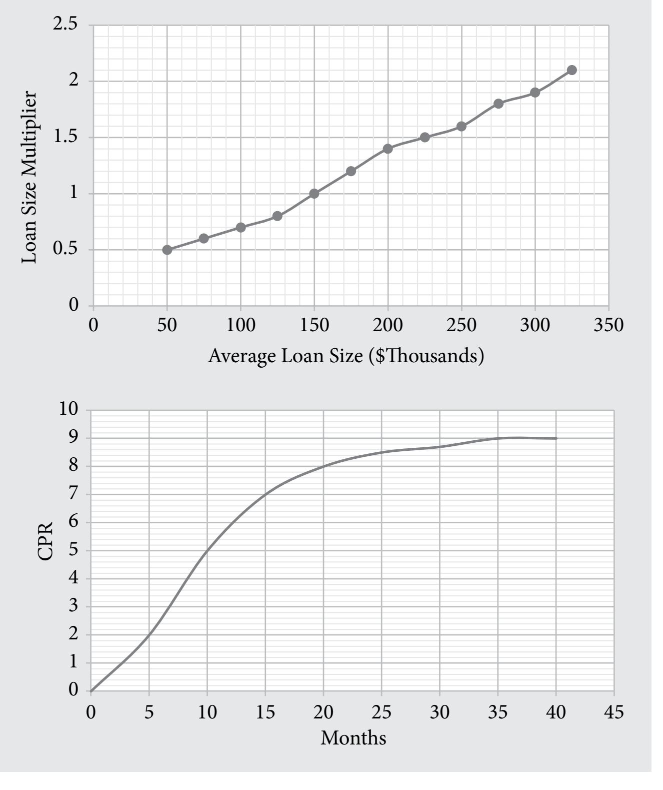

FIGURE 11.7 Loan size and age impact prepayment behavior

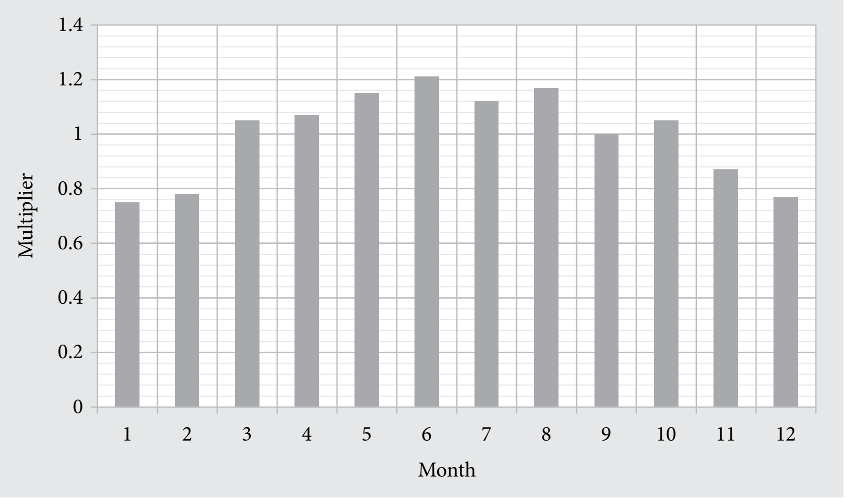

FIGURE 11.8 The effect of the school year on prepayments

Source: Charts constructed by author, using data from Credit Suisse

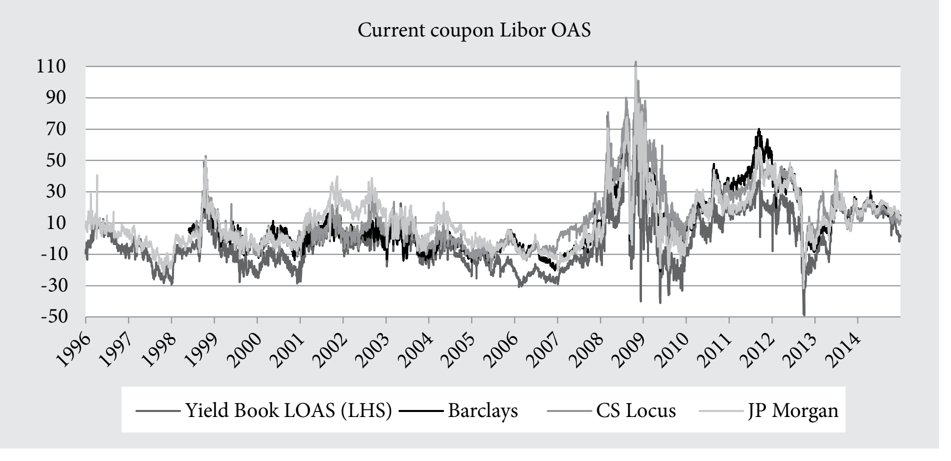

FIGURE 11.9 OAS estimates from different industry prepayment models

Source: Author-constructed figure from Yield Book, Barclays, Credit Suisse, and JP Morgan data

At any point in time, different coupon MBS trade in the market, reflecting disparate underlying mortgage rates. Figure 11.10 shows LIBOR OAS spreads from one provider grouped according to moneyness, which represents the difference between the rate on the loans in the MBS and current mortgage rates. Moneyness is a key valuation driver as it determines borrowers' incentive to prepay their loans. The chart uncovers an "OAS smile" in the MBS cross-section across coupon.

OAS spreads tend to be lowest for securities for which the prepayment option is at-the-money (ATM means that the distance from par is equal to 0), and increase if the option

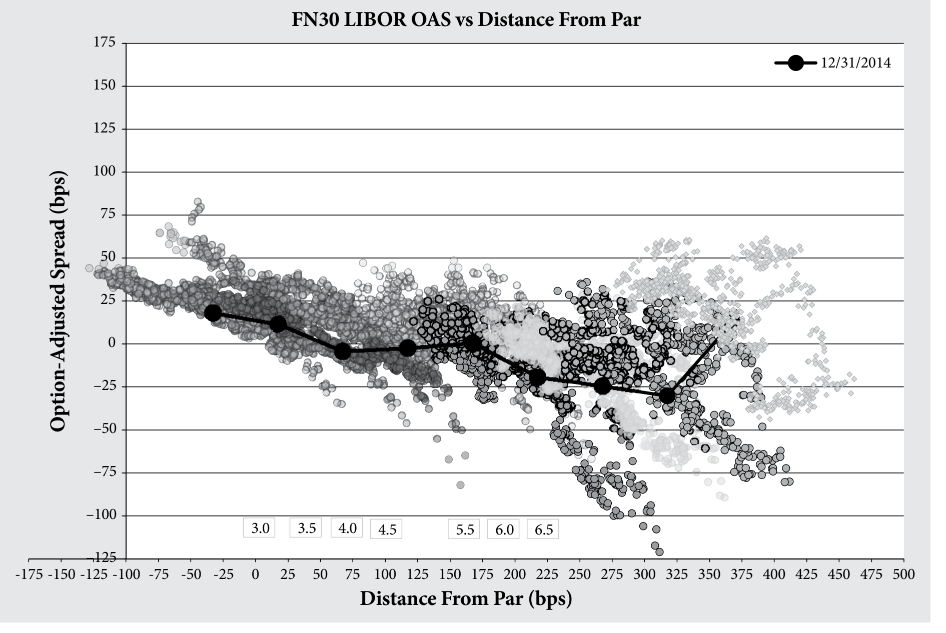

FIGURE 11.10 The OAS smile

Source: Author-constructed illustration from JP Morgan data

moves out-of-the-money (OTM) or in-the-money (ITM). While prepayment risk premia may generate the OAS smile, other risk factors such as liquidity could lead to such a pattern. For example, new issued (production coupon) MBS, which are around ATM, are more heavily traded and more readily available for delivery. Accordingly, the OAS of such coupons will be lower due to better liquidity. Discount coupons (OTM) may trade at a higher OAS because of the uncertainty related to extension risk and less liquidity.

Premium coupons (ITM) are generally off-the-run underlying borrowers that remain outstanding. By definition these borrowers have been exposed to refinancing incentives in the past, and a certain degree of burnout needs to be factored into the analysis of their prepayment reaction function.

Refinancing behavior is not static; it is a dynamic process that cannot be adequately captured by a fixed prepayment model. In fact, the interaction between refinancing sensitivity and borrower attributes often leads to model tweaking and recalibrations. The burnout effect refers to the way in which the experience of a refinancing wave dampens a pool of borrowers' refinancing sensitivity. If for no other reason, the prepayment reaction gently flattens over time as scheduled prepayments reduce the cost-savings incentive to refinance. During a refinancing wave, a borrower self-selection process ensues whereby borrowers with attributes conducive to refinancing elect to do so (generally reflecting a higher degree of financial acumen, higher loan balances and incomes, lower refinancing costs, and more built-in equity), while those with less accommodating circumstances are left behind (due to credit impairments, inadequate equity, smaller loan balances, etc.).

The smile effect shows up in total returns as well. Table 11.9 illustrates that over time, holding premium dollar price (ITM) securities has been a way to add excess

Table 11.9 Hidden alpha in pockets of the MBS sectors

	A	B	C	(A+C)/2	D	E	F	(D+F)/2
	Total returns as calculated by Barclays indices				Excess returns as calculated by Barclays indices			
	MBS Conv. 30 Year 98≤Price<100	MBS Conv. 30 Year 100≤Price<102	MBS Conv. 30 Year 102≤Price	Barbell Proxy	MBS Conv. 30 Year 98≤Price<100	MBS Conv. 30 Year 100≤Price<102	MBS Conv. 30 Year 102≤Price	Barbell Proxy
12/31/2014	4.60	5.77	5.44	5.02	0.44	0.45	0.39	0.42
12/31/2013	2.51	−6.13	−0.50	1.00	−0.17	−1.18	1.91	0.87
12/31/2012	1.68	0.67	2.61	2.15	−0.49	−0.61	0.83	0.17
12/30/2011	6.31	11.37	5.66	5.98	−0.95	−1.57	−1.42	−1.19
12/31/2010	4.03	5.67	5.21	4.62	0.68	−0.66	2.39	1.54
12/31/2009	4.09	1.11	6.15	5.12	1.43	3.08	5.34	3.39
12/31/2008	8.11	6.59	5.95	7.03	−3.48	−3.29	−2.87	−3.18
12/31/2007	6.59	6.58	7.14	6.87	−2.28	−1.43	-0.42	-1.35
12/29/2006	5.30	5.25	4.97	5.14	1.31	1.12	0.58	0.95
12/30/2005	3.61	2.23	2.71	3.16	−0.25	−0.73	−0.24	−0.25
12/31/2004	8.10	4.44	3.49	5.79	2.25	1.37	1.38	1.82
12/31/2003	−2.06	1.43	1.64	−0.21	−2.20	-1.46	−0.29	−1.25
12/31/2002	8.51	11.42	7.51	8.01	0.99	1.83	1.59	1.29
12/31/2001	7.82	8.06	7.43	7.63	−1.03	−0.82	−0.65	−0.84
12/29/2000	10.90	9.60	8.11	9.51	1.57	1.12	0.28	0.93
12/31/1999	0.42	1.62	3.16	1.79	n/a	n/a	n/a	n/a
12/31/1998	8.53	7.47	5.72	7.13	n/a	n/a	n/a	n/a
12/31/1997	10.07	9.97	8.51	9.29	n/a	n/a	n/a	n/a
12/31/1996	3.67	4.51	6.45	5.06	n/a	n/a	n/a	n/a
12/29/1995	16.72	15.07	12.18	14.45	n/a	n/a	n/a	n/a
12/30/1994	-1.67	−3.36	−0.32	−0.99	n/a	n/a	n/a	n/a
12/31/1993	10.78	10.09	6.65	8.71	n/a	n/a	n/a	n/a
12/31/1992	8.22	7.65	5.91	7.06	n/a	n/a	n/a	n/a
Average annual return	5.95	5.52	5.29	5.62	−0.15	−0.19	0.59	0.22
Standard deviation	4.34	4.94	2.89	3.49	1.63	1.64	1.88	1.61
Risk-adjusted return	1.37	1.12	1.83	1.61	−0.09	−0.11	0.31	0.14
Lowest yearly return	−2.06	−6.13	−0.50	−0.99	−3.48	−3.29	−2.87	−3.18
Number of negative years	2	2	2	2	8	9	6	6

Source: Authors' calculation based on data from Barclays (annual total returns from 1992–2014) return with lower volatility than discounts (OTM), or coupons trading around par (ATM). Risk-adjusted returns and drawdowns suggest that the price sensitivity of seasoned premiums is much smaller in comparison, as prepayment sensitivity declines with more burnout.

The table also shows that a barbell structure that captures the OAS smile outperforms (proxied here by an equal combination of OTM and ITM) compared to ATM coupons, which intrinsically have a higher variability in prepayment behavior (i.e. worst convexity).

The basis is the spread between a par 30-year mortgage yield and a similar duration par Treasury yield. Its main advantage is that the calculation does not require the use of prepayment models; however, the concept does not account for the fact that the value of the option can change over time, which changes the duration and convexity of a current coupon mortgage.

Normally, market participants construct this spread versus a blend of 5-year and 10-year on-the-run Treasuries. While the construction concept behind the basis is easy, it is important to keep in mind that both sides used in calculating the spread are somewhat theoretical. In practice, if an investor thinks the basis is cheap (MBS look attractive versus Treasuries), the investor would purchase the closest to par tradable TBA and hedge it duration-neutral with 10-year Treasuries based on a hedge ratio (dollar value of an 01, DV01) relationship.

Figure 11.11 shows the historical trends in the current coupon basis and the Yield Book LIBOR OAS since 1996. The *Yield Book Model*[1] was chosen due to its popularity and longest tracking record.

The broad trends in the OAS and the basis are similar; however, the historical perspective shows that the basis may trade at times at a significant premium relative to OAS. Panel (a) depicts the current coupon basis and OAS. Panel (b) shows the spread between the two spread metrics along with the MOVE index, a measure of interest rate volatility. When volatility is low or declining, the basis tends to overshoot the OAS tightening, and conversely when volatility is high and/or increasing. The MOVE index is Merrill Lynch Option Volatility Estimate, calculated as the weighted average of normalized implied volatility on one-month Treasury options on 2-year (CT2), 5-year (CT5), 10-year (CT10), and 30-year (CT30) with weights 0.2/0.2/0.4/0.2, respectively. It serves as a market proxy (benchmark) for rate volatility, rather than a tradable security.

In Figure 11.11, the basis was calculated as the par mortgage rate minus the average of the 5-year and 10-year Treasury rates. Other analysts define the basis as the spread versus 10-year or 5-year rates. Which is the right benchmark and what affects the "effective maturity" of the current

[1] The Yield Book is a widely used analytics platform for the fixed-income industry. Development started in 1989 at Salomon Brothers. More recently, modeling and development have been conducted by Citigroup's research and strategy teams.

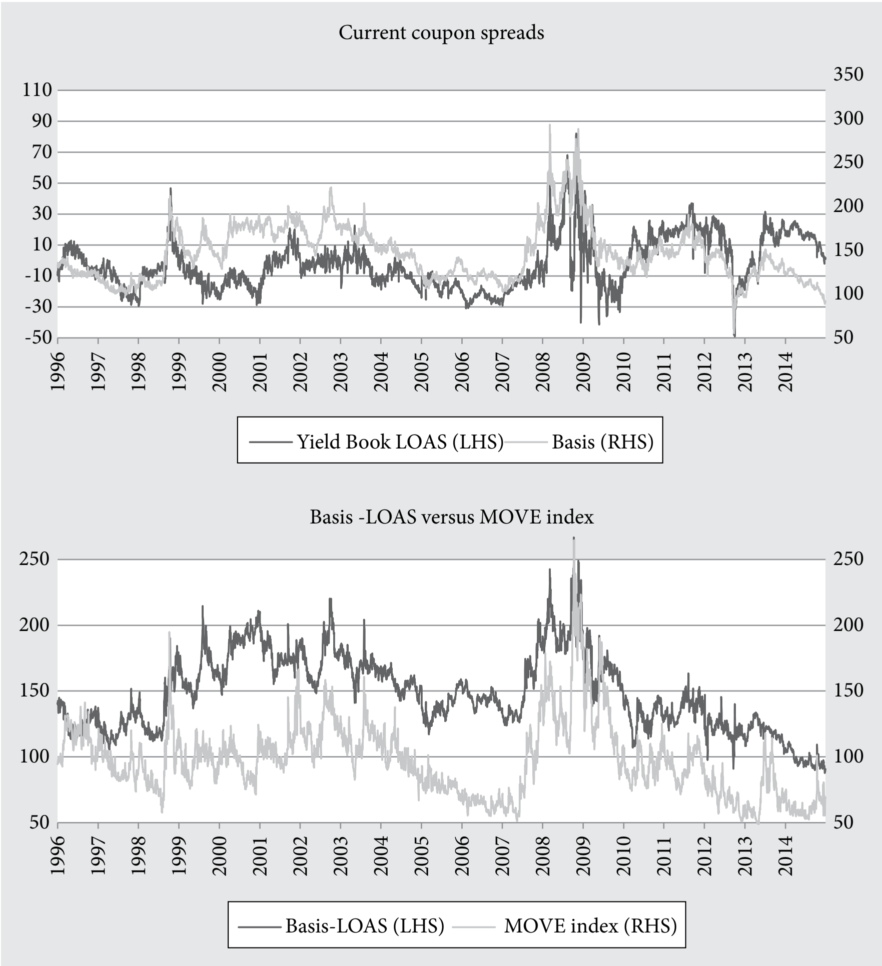

FIGURE 11.11 Current coupon spread metrics in historical perspective, 1996–2014

Source: Author-constructed charts based on data from Citigroup and Delaware Investments

coupon? In Figure 11.12, the effective Treasury maturity of the current coupon was simulated through time by interpolating between the 2-year, 5-year, and 10-year Treasury durations.

The effective maturity was five years in 2003, after being at four years earlier that year. Between 2005 and 2008, the effective maturity was between three and 4.5 years. Post 2009, the effective maturity has moved above 5.5 and peaked at 8.6 in 2013. The historical average line is at 5.3 years. There is clearly no single definition of the basis that will match mortgage and Treasury durations over time. However, the optionality (hence effective maturity) of the current coupon can be impacted by certain factors.

Refinance waves (proxied in Figure 11.13 by the Mortgage Bankers Association Refinance Index) lead to the creation of "new," lower-coupon, longer-duration MBS

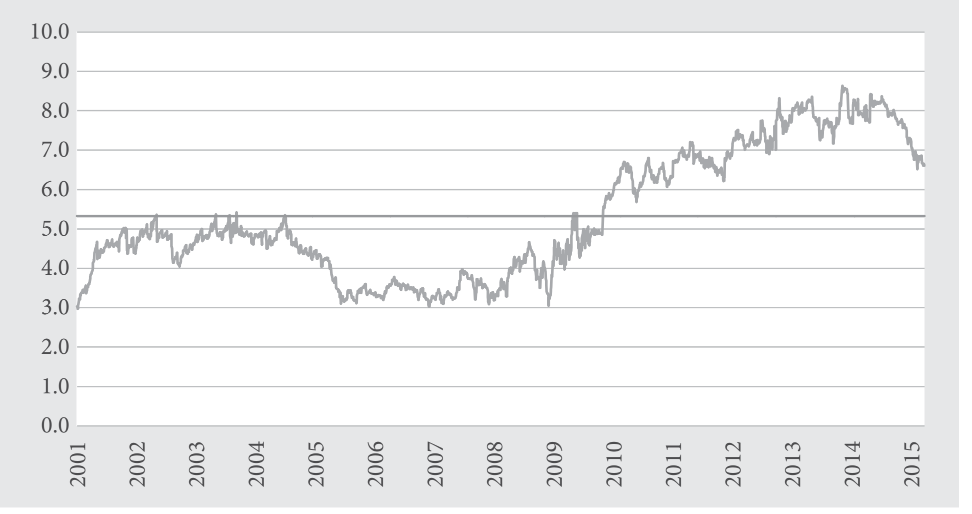

FIGURE 11.12 Evolution of current coupon effective duration

Source: Author-constructed charts based on data from Delaware Investments

securities, which are then included in the index, extending its duration. Lower-coupon securities mathematically have longer durations. This occurred in 2003 when the current coupon implied duration rapidly extended from four to five years. A similar extension happened following the 2009 refi wave.

Underwriting standards, home prices, and rate lock-in also play a role. For example, during 2005 and 2007, home prices were increasing and affordability products contributed to higher turnover and cash-out activity than normal. Accordingly, the effective maturity of the current coupon was impacted. Following the financial crisis, weakness in home prices and tight underwriting had the opposite effect. Additionally, rate lock-in effects have contributed to the extension process seen after mortgage rates reached historic lows of 3% to 3.25% in the aftermath of QE3.

An alternative enhancement to the "basis" concept is to adjust the spread for fundamental drivers of valuation. The basis tends to move in tandem with swap spreads (which generally capture changes in the market premium for general credit condition and liquidity). Additionally, investors are always trying to assess the relative value between similar quality spread products. In the case of MBS, investment-grade corporate bonds are an alternative sector. The idea of normalized spreads is to forecast the basis using a regression model that incorporates drivers of valuations. Figure 11.14 shows a model of the current coupon basis as a function of the LIBOR curve (2-year/5-year/10-year/30-year LIBOR), rates volatility, swap spreads, and investment-grade corporate spreads. This is a fair value approach, where the investor forecasts a predicted value for the basis using one year of rolling data, and compares it versus the actual spread. The purpose is to isolate an adaptive short-term rich/cheap signal focused on the residual, which serves as an additional input in the valuation exercise.

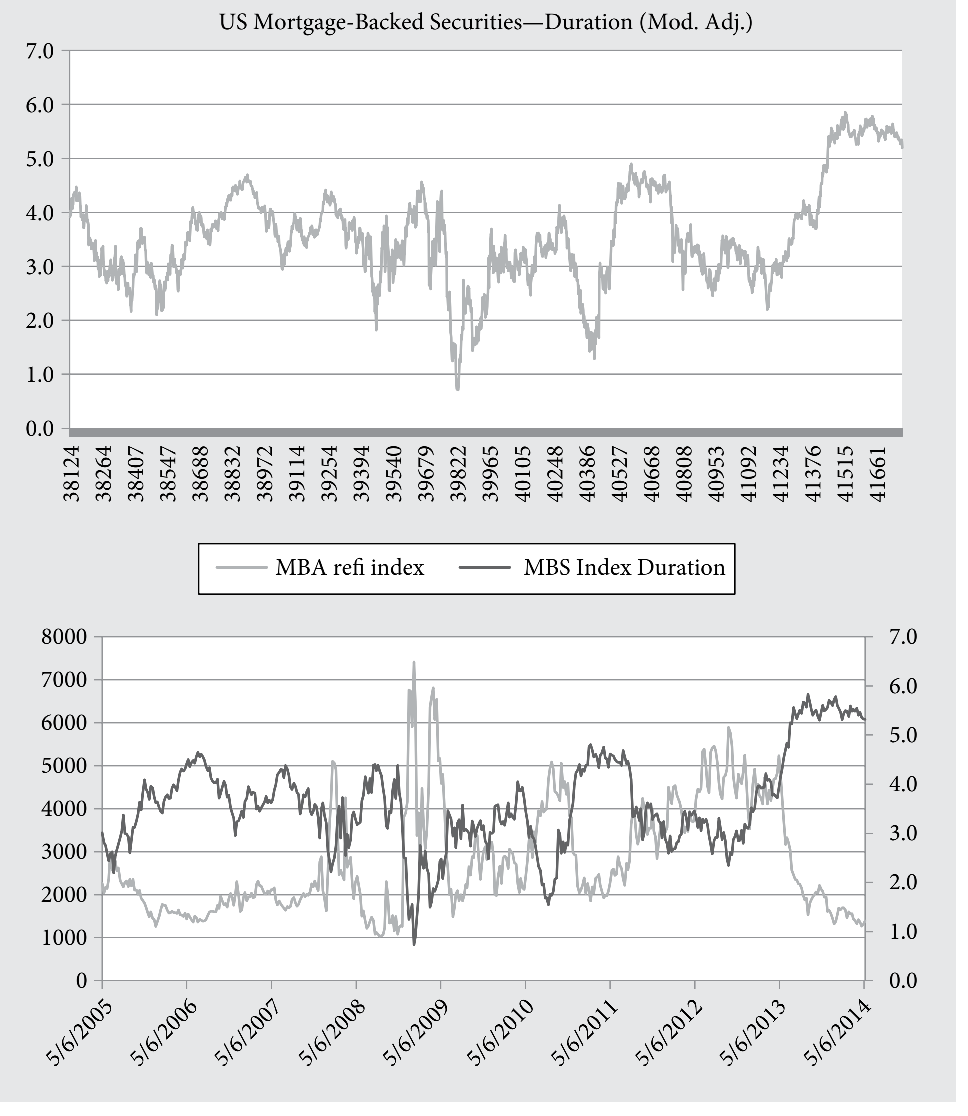

FIGURE 11.13 MBS durations and refinancing activity

Source: Author-constructed charts based on data from Mortgage Bankers Association and Barclays

Key Points

- From a downside protection standpoint, compared to other high-grade fixed-income sectors, such as Treasuries and investment-grade corporate bonds, agency MBS had the least number of negative quarters, and more mild drawdowns over the last 24 years.
- Over long horizons, agency MBS delivered superior returns compared to Treasuries and better risk-adjusted returns compared to corporate bonds.
- Historically, agency MBS have been most correlated to Treasuries and least correlated to equity risk. This feature offers diversification benefits.

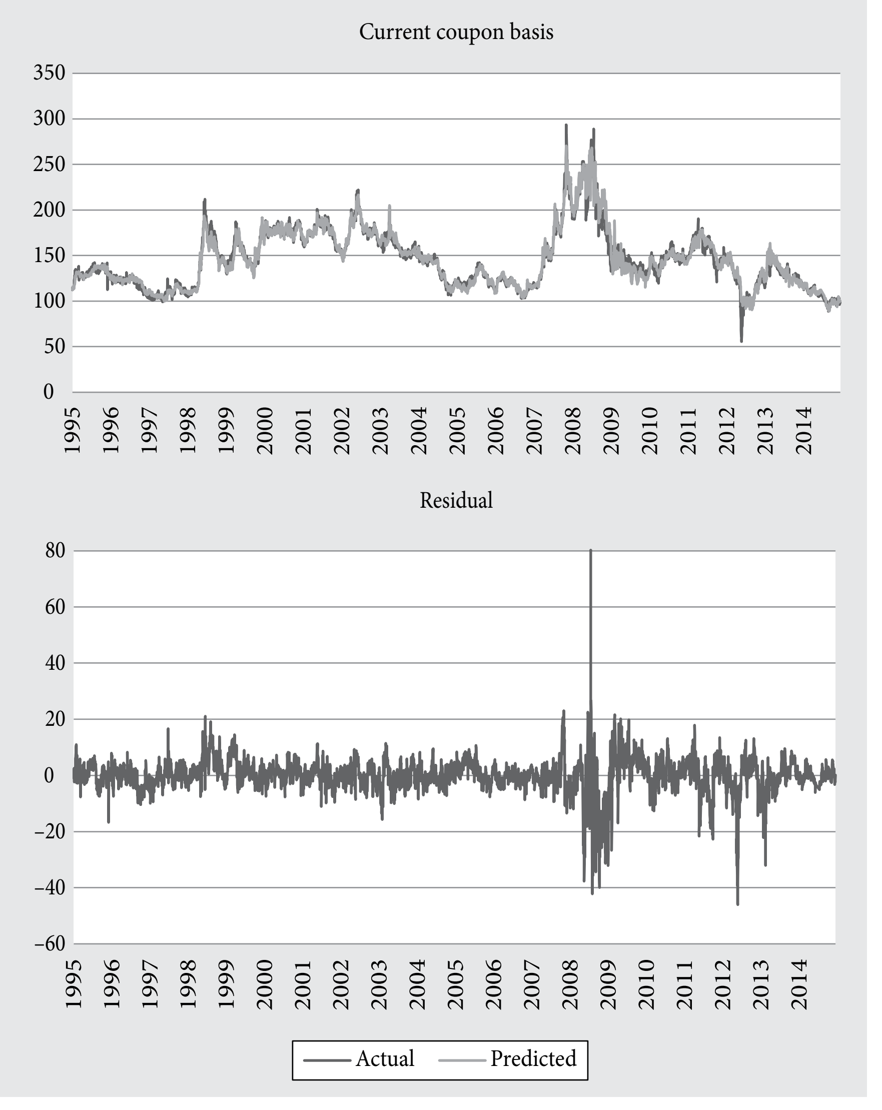

FIGURE 11.14 Adjusting the basis

Source: Author-constructed charts based on data from Delaware Investments and Barclays

- Over longer horizons, yield and duration are the major drivers of total return in fixed-income markets. Yields (adjusted for duration and yield volatility) are superior in agency MBS compared to other investment grade sectors.
- Replicating the performance of the Barclays US MBS Index is not a trivial exercise and requires a depth of market knowledge because index constituents are not actual securities but aggregate, nontraded generic representations of various pools of mortgages.
- Assessing the risk–reward in agency MBS is both an art form and a science. The complexity associated with understanding prepayment behavior has important implications for both modeling and valuation methodologies.

Acknowledgment

Index performance returns do not reflect any management fees, transaction costs, or expenses. Indices are unmanaged and one cannot invest directly in an index. All third-party marks cited are the property of their respective owners. Opinions expressed are the authors and not necessarily those of their employer.

PART III

AGENCY RMBS: MULTI-CLASS

CHAPTER 12

AGENCY COLLATERALIZED MORTGAGE OBLIGATIONS

FRANK J. FABOZZI

After reading this chapter, you will understand:

- the motivation for the creation of an agency collateralized mortgage obligation;
- how the bond classes in a CMO structure are created;
- the rules used in a CMO structure for distributing the principal and interest payments among bond classes;
- the different types of bond classes: sequential-pay, accrual bond, floater, inverse floater, planned amortization class bond, targeted amortization class bond, very accurately determined class bond, notional interest-only bond, and support bond;
- the different forms of prepayment risk: contraction risk and extension risk;
- the exposure of the different types of bond classes to prepayment risk.

In this chapter, an overview of the different types of agency collateralized mortgage obligations (CMOs) is provided. Unlike agency passthrough securities, which have only one bond class, agency CMOs have multiple bond classes that are supported by the collateral. Agency CMOs are issued by the same entities that issue agency passthrough securities—Ginnie Mae, Fannie Mae, and Freddie Mac—and carry the credit risk of those issuers. Although non-agency or private-label CMOs also have multiple bond classes, the bond classes are divided into senior and several levels of subordinated bond classes. The subordinated bond classes provide credit protection for the senior bond classes.

Rather than simply describing the characteristics of the different types of bond classes that may be included in an agency CMO transaction, we will see how they are structured, beginning with the collateral, agency passthrough securities.

Prepayment Risk: Contraction and Extension Risks

When investing in a mortgage passthrough security, an investor is exposed to prepayment risk—the uncertainty about the cash flow due to prepayments. But prepayment risk can be decomposed into contraction risk and extension risk.

Contraction risk is the risk that an MBS life will be shorter than expected when the security was purchased because prepayments are faster than expected. There are two adverse consequences that an investor who faces contraction risk encounters. First, the price of an option-free bond will rise when interest rates decline. But in the case of a mortgage passthrough security, the rise in price will not be as large as that of an option-free bond because a fall in interest rates increases the borrower's incentive to prepay the loan and refinance at a lower rate. This results in the same adverse consequence faced by holders of callable corporate and municipal bonds. The effect is that the upside price potential of a mortgage passthrough security is truncated because of prepayments, a bond attribute referred to as *negative convexity*. The second adverse consequence is that since an MBS will realize faster prepayments when mortgage rates decline, the receipt of principal repayment must be reinvested at a lower interest rate (i.e., the investor faces reinvestment risk).

Now consider what happens when interest rates rise. The price of a mortgage passthrough security will decline when interest rates rise. However, it will decline more because the higher rates will tend to slow down the rate of prepayment, in effect increasing the amount invested at the coupon rate, which is lower than the market rate. Of course, this is just the time when investors want prepayments to speed up so that they can reinvest the prepayments at the prevailing interest rate. This adverse consequence of rising mortgage rates is called *extension risk*.

Some institutional investors are concerned with extension risk when they invest in a mortgage passthrough security while others are more concerned with contraction risk. Fortunately, redirecting cash flows from a mortgage passthrough security to various bond classes makes it possible to redistribute prepayment risk for investors who want to reduce their exposure to the particular form of prepayment risk for which they are concerned. Because the collateral's prepayment risk will not be changed by redirecting the cash flows, other investors must be found who are willing to accept the unwanted prepayment risk.

Agency CMOs are bond classes created by redirecting the collateral's cash flows in such a way so as to mitigate prepayment risk. But just creating a CMO does not eliminate prepayment risk. Rather, it can only transfer the two forms of prepayment risk among different classes of bondholders. The technique of redistributing the coupon interest and principal from the collateral to different bond classes in a CMO deal that results in a different coupon rate from that for the collateral, results in bond classes that have varying risk–return characteristics that may be more suitable to the needs and expectations of investors. The creation of different bond classes with more appealing risk–return attributes broadens the appeal of mortgage-related products to institutional investors who would otherwise shun or minimize their exposure to the mortgage sector due to prepayment risk.

A CMO deal provides a set of rules for how (1) the collateral's interest is to be distributed amongst the bond classes, and (2) the collateral's principal (regularly scheduled payments and prepayments, with no distinction between the two) is to be distributed amongst the bond classes in order to retire the bond classes. In agency CMO deals, there is no mechanism/rule for dealing with credit losses. In contrast, with non-agency CMO deals, there are rules for the distribution of losses amongst bond classes. In agency CMO deals, all of the rules are provided in the prospectus supplement. As we create different CMO deals in this chapter, we will create a mini-prospectus supplement.

In the prospectus and supplementary prospectus, CMOs are referred to as a Real Estate Mortgage Investment Conduit (REMIC) because of an applicable provision in the tax code. More specifically, issuers, both agency and non-agency issuers, structure their CMO deals so as to qualify for REMIC tax treatment. Rather than referring to this multi-class mortgage structure as a CMO, the preference is to refer to it as a REMIC.

Collateral

An agency CMO is backed by agency mortgage passthrough securities which are referred to as the collateral. Information about the agency mortgage passthrough securities is given in the deal's prospectus. In Table 12.1 we provide a hypothetical mortgage passthrough security that will serve as the collateral for the various CMO deals (with different bond classes) that we create in this chapter to illustrate the different bond classes and their characteristics. Moreover, by looking at the attributes of the collateral, we can see why institutional investors would prefer certain types of bond classes to fulfill their investment objectives and not the collateral itself.

Table 12.1 Prospectus: Description of the mortgage passthrough security

Type of loan: Fixed rate
Aggregate par: $400 million
Weighted-average coupon: 8.125%
Coupon rate: 7.5%
Weighted-average maturity (WAM): 357 months
Seasoned: 3 months

Constructing the Monthly Cash Flow

It is the cash flow from the collateral that is used to retire each bond class and pay monthly interest due to each bond class. Therefore, the first step in creating a CMO is to project its cash flow. However, the cash flow is uncertain due to prepayments. Consequently, in projecting the collateral's cash flow it is necessary to make some assumption about future prepayment rates. As explained in earlier chapters, there are various prepayment metrics that can be used. Typically, prepayment rate forecasts are cast in terms of the Public Securities prepayment benchmark.

For the collateral given in the prospectus (Table 12.1), Table 12.2 shows the monthly cash flow assuming 165 PSA. The cash flow is broken down into three components: (1) interest (based on the passthrough rate), (2) the regularly scheduled principal repayment, and (3) prepayments based on 165 PSA. An explanation for the calculation of the values shown in columns 2 through 9 is provided in Chapter 3.

Table 12.2 Monthly cash flow for a $400 million mortgage passthrough security with a 7.5% coupon rate with a WAC of 8.125% and a WAM of 357 months assuming 165 PSA

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Month	Outstanding Balance	SMM	Mortgage Payment	Interest	Scheduled Principal	Prepayment	Total Principal	Total Cash Flow
1	400,000,000	0.00111	2,975,868	2,500,000	267,535	442,389	709,923	3,209,923
2	399,290,077	0.00139	2,972,575	2,495,563	269,048	552,847	821,896	3,317,459
3	398,468,181	0.00167	2,968,456	2,490,426	270,495	663,065	933,560	3,423,986
4	397,534,621	0.00195	2,963,513	2,484,591	271,873	772,949	1,044,822	3,529,413
5	396,489,799	0.00223	2,957,747	2,478,061	273,181	882,405	1,155,586	3,633,647
6	395,334,213	0.00251	2,951,160	2,470,839	274,418	991,341	1,265,759	3,736,598
7	394,068,454	0.00279	2,943,755	2,462,928	275,583	1,099,664	1,375,246	3,838,174
8	392,693,208	0.00308	2,935,534	2,454,333	276,674	1,207,280	1,483,954	3,938,287
9	391,209,254	0.00336	2,926,503	2,445,058	277,690	1,314,099	1,591,789	4,036,847
10	389,617,464	0.00365	2,916,666	2,435,109	278,631	1,420,029	1,698,659	4,133,769
11	387,918,805	0.00393	2,906,028	2,424,493	279,494	1,524,979	1,804,473	4,228,965
12	386,114,332	0.00422	2,894,595	2,413,215	280,280	1,628,859	1,909,139	4,322,353
13	384,205,194	0.00451	2,882,375	2,401,282	280,986	1,731,581	2,012,567	4,413,850
14	382,192,626	0.00480	2,869,375	2,388,704	281,613	1,833,058	2,114,670	4,503,374
15	380,077,956	0.00509	2,855,603	2,375,487	282,159	1,933,203	2,215,361	4,590,848
16	377,862,595	0.00538	2,841,068	2,361,641	282,623	2,031,931	2,314,554	4,676,195
17	375,548,041	0.00567	2,825,779	2,347,175	283,006	2,129,159	2,412,164	4,759,339
18	373,135,877	0.00597	2,809,746	2,332,099	283,305	2,224,805	2,508,110	4,840,210

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Month	Outstanding Balance	SMM	Mortgage Payment	Interest	Scheduled Principal	Prepayment	Total Principal	Total Cash Flow
19	370,627,766	0.00626	2,792,980	2,316,424	283,521	2,318,790	2,602,312	4,918,735
20	368,025,455	0.00656	2,775,493	2,300,159	283,654	2,411,036	2,694,690	4,994,849
21	365,330,765	0.00685	2,757,296	2,283,317	283,702	2,501,466	2,785,169	5,068,486
22	362,545,596	0.00715	2,738,402	2,265,910	283,666	2,590,008	2,873,674	5,139,584
23	359,671,922	0.00745	2,718,823	2,247,950	283,545	2,676,588	2,960,133	5,208,083
24	356,711,789	0.00775	2,698,575	2,229,449	283,338	2,761,139	3,044,477	5,273,926
25	353,667,312	0.00805	2,677,670	2,210,421	283,047	2,843,593	3,126,640	5,337,061
26	350,540,672	0.00835	2,656,123	2,190,879	282,671	2,923,885	3,206,556	5,397,435
27	347,334,116	0.00865	2,633,950	2,170,838	282,209	3,001,955	3,284,164	5,455,002
28	344,049,952	0.00865	2,611,167	2,150,312	281,662	2,973,553	3,255,215	5,405,527
29	340,794,737	0.00865	2,588,581	2,129,967	281,116	2,945,400	3,226,516	5,356,483
30	337,568,221	0.00865	2,566,190	2,109,801	280,572	2,917,496	3,198,067	5,307,869
...								
100	170,142,350	0.00865	1,396,958	1,063,390	244,953	1,469,591	1,714,544	2,777,933
101	168,427,806	0.00865	1,384,875	1,052,674	244,478	1,454,765	1,699,243	2,751,916
102	166,728,563	0.00865	1,372,896	1,042,054	244,004	1,440,071	1,684,075	2,726,128
103	165,044,489	0.00865	1,361,020	1,031,528	243,531	1,425,508	1,669,039	2,700,567
104	163,375,450	0.00865	1,349,248	1,021,097	243,060	1,411,075	1,654,134	2,675,231
105	161,721,315	0.00865	1,337,577	1,010,758	242,589	1,396,771	1,639,359	2,650,118
...								
200	56,746,664	0.00865	585,990	354,667	201,767	489,106	690,874	1,045,540
201	56,055,790	0.00865	580,921	350,349	201,377	483,134	684,510	1,034,859
202	55,371,280	0.00865	575,896	346,070	200,986	477,216	678,202	1,024,273
203	54,693,077	0.00865	570,915	341,832	200,597	471,353	671,950	1,013,782
204	54,021,127	0.00865	565,976	337,632	200,208	465,544	665,752	1,003,384
205	53,355,375	0.00865	561,081	333,471	199,820	459,789	659,609	993,080
...								
300	11,758,141	0.00865	245,808	73,488	166,196	100,269	266,465	339,953
301	11,491,677	0.00865	243,682	71,823	165,874	97,967	263,841	335,664
302	11,227,836	0.00865	241,574	70,174	165,552	95,687	261,240	331,414
303	10,966,596	0.00865	239,485	68,541	165,232	93,430	258,662	327,203
304	10,707,934	0.00865	237,413	66,925	164,912	91,196	256,107	323,032
305	10,451,827	0.00865	235,360	65,324	164,592	88,983	253,575	318,899
...								
350	1,235,674	0.00865	159,202	7,723	150,836	9,384	160,220	167,943
351	1,075,454	0.00865	157,825	6,722	150,544	8,000	158,544	165,266
352	916,910	0.00865	156,460	5,731	150,252	6,631	156,883	162,614
353	760,027	0.00865	155,107	4,750	149,961	5,277	155,238	159,988
354	604,789	0.00865	153,765	3,780	149,670	3,937	153,607	157,387
355	451,182	0.00865	152,435	2,820	149,380	2,611	151,991	154,811
356	299,191	0.00865	151,117	1,870	149,091	1,298	150,389	152,259
357	148,802	0.00865	149,809	930	148,802	0	148,802	149,732

Collateral's Average Life

Let's look at the average life of the collateral based on different prepayment assumptions. The following table shows the average life assuming prepayment rates from 50 PSA to 300 PSA:

PSA	50	100	165	200	300
Average life	15.11	11.66	8.76	7.68	5.63

The average life varies from 5.63 years if the prepayment rate is 300 PSA to 15.11 if the prepayment rate is 50 PSA. The drawback of this security is the considerable variation in its average life. Most institutional investors search for securities within specified maturity ranges. However, because of prepayment risk, this security could turn out to be one in the 5- to 7-year range or if prepayment speeds slow down considerably, a security that exceeds 15 years before it is fully paid off.

What we will see in the balance of the chapter as we describe the different types of bond classes is how the rules for the distribution of principal result in a narrowing of the range of the average life of some bond classes. In certain CMO structures this can result in the narrowing of the range of the average life of other bond classes in the structure or it can result in even greater variation in the average life of some bond classes in the structure. In the latter case, this results in bond classes that have more prepayment risk than the collateral itself. Such bond classes are not necessarily bad investments. Rather, the price paid by investors should reflect the increase in prepayment risk with which such bond classes expose investors.

Sequential-Pay Bond Classes

In the balance of this chapter, we will describe the different types of bond classes using the collateral in Table 12.1 and the collateral's monthly cash flow based on 165 PSA as shown in Table 12.2. We shall refer to each CMO structure as Deal 1, Deal 2, and so on.

The first type of bond class in a CMO deal we shall describe is a simple one: a sequential-pay bond class. Table 12.3 shows the supplementary prospectus for Deal 1 that shows the bond classes in the structure and the rules for distribution of interest and principal. Notice that the total par value of the four bond classes is equal to the par value of the collateral.

In this simple structure, the coupon rate is the same for each bond class and also the same as the coupon rate for the collateral. There is no reason why this must be so, and in

Table 12.3 Prospectus supplement for Deal 1

BOND CLASSES

Bond Class	Par Amount	Coupon Rate (%)
A	$194,500,000	7.5
B	36,000,000	7.5
C	96,500,000	7.5
D	73,000,000	7.5
	$400,000,000	

Rules for Distribution of Principal and Interest

1. *For payment of periodic coupon interest*: Disburse periodic coupon interest to each bond class on the basis of the amount of principal outstanding at the beginning of the period.
2. *For disbursement of principal payments*: Disburse principal payments to bond class A until it is paid off completely. After bond class A is paid off completely, disburse principal payments to bond B until it is paid off completely. After bond class B is paid off completely, disburse principal payments to bond class C until it is paid off completely. After bond class C is paid off completely, disburse principal payments to bond class D until it is paid off completely.

fact, typically the coupon rate varies by bond class. In Deal 1, each bond class receives periodic coupon interest payments based on the amount of the outstanding balance at the beginning of the month. This is not the case for principal. The distribution of principal is such that a bond class is not entitled to receive principal until the principal of the preceding bond class has been paid off in its entirety. That is, bond class A receives all of the collateral's principal payments until the entire $194,500,000 of principal amount owed to that bond class is paid off. At that time, bond class B begins to receive principal and continues to do so until $36,000,000 is received by that bond class. Once that occurs, bond class C receives principal, and when it is paid off, bond class D receives all distribution of the collateral's principal payments.

This seems like a simple enough structure. However, despite the priority rules for the distribution of the principal payments, the precise amount of the principal in each period is not known. This will depend on the collateral's cash flow which, in turn, depends on the actual prepayment rate of the collateral. An assumed PSA speed allows the cash flow to be projected. Table 12.2 shows the cash flow (interest, regularly scheduled principal repayment, and repayments) assuming 165 PSA. Assuming that the collateral does prepay at 165 PSA, the cash flow available to all four bond classes of Deal 1 will be precisely the cash flow shown in Table 12.2.

Table 12.4 shows the cash flow for selected months assuming that the collateral prepays at 165 PSA. For each bond class, the table shows (1) the balance at the end of the month, (2) the principal paid down (regularly scheduled principal repayment plus prepayments), and (3) interest. In reviewing Table 12.4, note that:

Table 12.4 Monthly cash flow for selected months for Deal 1 assuming 165 PSA

	Bond Class A			Bond Class B		
Month	Balance	Principal	Interest	Balance	Principal	Interest
1	194,500,000	709,923	1,215,625	36,000,000	0	225,000
2	193,790,077	821,896	1,211,188	36,000,000	0	225,000
3	192,968,181	933,560	1,206,051	36,000,000	0	225,000
4	192,034,621	1,044,822	1,200,216	36,000,000	0	225,000
5	190,989,799	1,155,586	1,193,686	36,000,000	0	225,000
6	189,834,213	1,265,759	1,186,464	36,000,000	0	225,000
7	188,568,454	1,375,246	1,178,553	36,000,000	0	225,000
8	187,193,208	1,483,954	1,169,958	36,000,000	0	225,000
9	185,709,254	1,591,789	1,160,683	36,000,000	0	225,000
10	184,117,464	1,698,659	1,150,734	36,000,000	0	225,000
11	182,418,805	1,804,473	1,140,118	36,000,000	0	225,000
12	180,614,332	1,909,139	1,128,840	36,000,000	0	225,000
75	12,893,479	2,143,974	80,584	36,000,000	0	225,000
76	10,749,504	2,124,935	67,184	36,000,000	0	225,000
77	8,624,569	2,106,062	53,904	36,000,000	0	225,000
78	6,518,507	2,087,353	40,741	36,000,000	0	225,000
79	4,431,154	2,068,807	27,695	36,000,000	0	225,000
80	2,362,347	2,050,422	14,765	36,000,000	0	225,000
81	311,926	311,926	1,950	36,000,000	1,720,271	225,000
82	0	0	0	34,279,729	2,014,130	214,248
83	0	0	0	32,265,599	1,996,221	201,660
84	0	0	0	30,269,378	1,978,468	189,184
85	0	0	0	28,290,911	1,960,869	176,818
95	0	0	0	9,449,331	1,793,089	59,058
96	0	0	0	7,656,242	1,777,104	47,852
97		0	0	5,879,138	1,761,258	36,745
98		0	0	4,17,880	1,745,550	25,737
99		0	0	2,372,329	1,729,979	14,827
100		0	0	642,350	642,350	4,015
101		0	0	0	0	0
	Bond Class C			Bond Class D		
1	96,500,000	0	603,125	73,000,000	0	456,250
99	96,500,000	0	603,125	73,000,000	0	456,250
100	96,500,000	1,072,194	603,125	73,000,000	0	456,250
101	95,427,806	1,699,243	596,424	73,000,000	0	456,250
102	93,728,563	1,684,075	585,804	73,000,000	0	456,250
103	92,044,489	1,669,039	575,278	73,000,000	0	456,250
104	90,375,450	1,654,134	564,847	73,000,000	0	456,250
105	88,721,315	1,639,359	554,508	73,000,000	0	456,250
175	3,260,287	869,602	20,377	73,000,000	0	456,250
176	2,390,685	861,673	14,942	73,000,000	0	456,250
177	1,529,013	853,813	9,556	73,000,000	0	456,250
178	675,199	675,199	4,220	73,000,000	170,824	456,250
179	0	0	0	72,829,176	838,300	455,182
180	0	0	0	71,990,876	830,646	449,943

Table 12.4 Continued

	Bond Class C			Bond Class D		
Month	Balance	Principal	Interest	Balance	Principal	Interest
181	0	0	0	71,160,230	823,058	444,751
182	0	0	0	70,337,173	815,536	439,607
183	0	0	0	69,521,637	808,081	434,510
184	0	0	0	68,713,556	800,690	429,460
185	0	0	0	67,912,866	793,365	424,455
350	0	0	0	1,235,674	160,220	7,723
351	0	0	0	1,075,454	158,544	6,722
352	0	0	0	916,910	156,883	5,731
353	0	0	0	760,027	155,238	4,750
354	0	0	0	604,789	153,607	3,780
355	0	0	0	451,182	151,991	2,820
356	0	0	0	299,191	150,389	1,870
357	0	0	0	148,802	148,802	930

- In month 1, the cash flow for the collateral consists of a principal payment of \$709,923 and interest of \$2.5 million (7.5% of \$400 million divided by 12). The interest payment is distributed to the four bond classes based on the amount of the par value outstanding. So, for example, bond class A receives \$1,215,625 (7.5% of \$194,500,000 divided by 12) of the \$2.5 million. The principal, however, is all distributed to bond class A. Therefore, the cash flow for bond class A in month 1 is \$1,925,548.
- Bond class A's principal balance at the end of month 1 is \$193,790,076 (the original principal balance of \$194,500,000 less the principal payment of \$709,923). In month 1, no principal payment is distributed to the three other bond classes (B, C, and D) because there is still a principal balance outstanding for bond class A. This will be true for months 2 through 80.
- After month 81, the principal balance will be zero for bond class A. For the collateral, the cash flow in month 81 is \$3,318,521, consisting of a principal payment of \$2,032,196 and interest of \$1,286,325. At the beginning of month 81 (end of month 80), the principal balance for bond class A is \$311,926. Therefore, \$311,926 of the \$2,032,196 of the principal payment from the collateral will be disbursed to bond class A.
- After the payment is made to bond class A in month 81, no additional principal payments are made to this bond class as the principal balance is zero. The remaining principal payment from the collateral, \$1,720,271, is disbursed to bond class B.

- Assuming a prepayment rate of 165 PSA, bond class B begins receiving principal payments in month 81. That bond class is fully paid off by month 100, when bond class C then begins to receive principal payments.
- Bond class C is not fully paid off until month 178, at which time bond class D begins receiving the remaining principal payments.
- The projected maturity (i.e., the time until the principal is fully paid off) for these four bond classes assuming 165 PSA is:

  Bond class A: 81 months
  Bond class B: 100 months
  Bond class C: 178 months
  Bond class D: 357 months

- The principal paydown window for a bond class is the time period between the beginning and the ending of the principal payments. For example, for bond class A, the principal paydown window would be month 1 to month 81 assuming 165 PSA. For bond class B it is from month 82 to month 100. The window is also specified in terms of the length of the time from the beginning of the principal paydown window to the end of the principal paydown window. For bond A, the window would be stated as 80 months; for bond class B, 19 months.

Sequential-Pay Bond Classes and Exposure to Prepayment Risk

Let's look at what has been accomplished by creating the CMO, and we can do so by looking at the average life of the four bond classes. As stated earlier, the average life of the mortgage passthrough security is 8.76 years assuming a prepayment speed of 165 PSA. Table 12.5 gives the average life of the collateral and the four bond classes assuming different prepayment speeds. As can be seen, there are not only bond classes with different average lives than the collateral, but also with less average life variation. The ability to more closely target an average life and with less prepayment risk (due to less average life variation) makes the CMOs in this structure more appealing to investors.

There still remains considerable variability of the average life for the bond classes. We will see later how this can be dealt with as we introduce other types of bond classes into a CMO structure. However, even in this simple CMO structure, some protection is provided for each bond class against prepayment risk. This is because prioritizing the distribution of principal effectively protects the shorter-term bond class A in this structure against extension risk. This protection is provided by the three other bond classes. Similarly, bond classes C and D provide protection against extension risk for bond classes A and B. At the same time, bond classes C and D benefit because they are

Table 12.5 Average life for the collateral and the four bond classes in Deal 1

Speed (PSA)	Collateral	A	B	C	D
50	15.11	7.48	15.98	21.02	27.24
100	11.66	4.90	10.86	15.78	24.58
165	8.76	3.48	7.49	11.19	20.27
200	7.68	3.05	6.42	9.60	18.11
300	5.63	2.32	4.64	6.81	13.36
400	4.44	1.94	3.70	5.31	10.34

provided protection against contraction risk, that protection arising from the presence of bond classes A and B.

Accrual Bonds

In the simple sequential-pay CMO structure given by Deal 1, the payment rules call for interest to be paid to each bond class month until the bond class matures. However, that need not be the case, and by not paying interest initially to some bond classes, it allows the creation of some more appealing bond classes. When there is a bond class where the interest accrues rather than being paid out and thereby the accruing interest is added to the principal balance, such bond classes are referred to as *accrual bond classes*.[1] They are also referred to as *Z bonds* because the bond is similar to a zero-coupon bond. The interest that would have been paid to the accrual bond class is then used to speed up paying off the principal balance of earlier bond classes in the CMO structure.

To see this, consider Deal 2 whose prospectus supplement is shown as Table 12.6. Deal 2 differs from Deal 1 in that the last bond class, bond class Z, is an accrual bond. Table 12.7 shows the cash flow for selected months for bond classes A and B. Consider month 1 and let's compare it with month 1 in Table 12.4. Both cash flows are based on 165 PSA. The principal payment from the collateral is $709,923. In Deal 1, this is the principal paydown for bond class A. In Deal 2, the interest for bond class Z, $456,250, is not paid to that bond class but instead is used to pay down the principal of bond class A. So the principal payment to bond class A in Table 12.7 is $1,166,173, the collateral's principal payment of $709,923 plus the interest of $456,250 that was diverted from bond class Z.

[1] Additional information about accrual bonds is provided in Chapter 14.

Table 12.6 Prospectus supplement for Deal 2

BOND CLASSES		
Bond Classes	Par Amount	Coupon Rate (%)
A	$194,500,000	7.5
B	36,000,000	7.5
C	96,500,000	7.5
Z (accrual)	73,000,000	7.5
	$400,000,000	

Rules for Distribution of Principal and Interest

1. *For payment of periodic coupon interest*: Disburse periodic coupon interest to bond classes A, B, and C on the basis of the amount of principal outstanding at the beginning of the period. For bond class Z, accrue the interest based on the principal plus accrued interest in the preceding period. The interest for bond class Z is to be paid to the earlier bond classes as a principal paydown.
2. *For disbursement of principal payments*: Disburse principal payments to bond class A until it is completely paid off. After bond class A is paid off completely, disburse principal payments to bond class B until it is paid off completely. After bond class B is paid off completely, disburse principal payments to bond class C until it is paid off completely. After bond class C is paid off completely, disburse principal payments to bond class Z, until the original principal balance plus accrued interest is paid off completely.

Impact of Accrual Bond Class on Prepayment Risk

The expected final maturity for bond classes A, B, and C has shortened as a result of the inclusion of bond class Z. The final payout for bond class A is 64 months rather than 81 months; for bond class B it is 77 months rather than 100 months; and for bond class C it is 112 rather than 178 months.

The average lives for the non-accrual bond classes (A, B, and C) are shorter in Deal 2 than in Deal 1 because of the inclusion of the accrual bond. For example, at 165 PSA, the average lives are as follows:

Structure	Bond Class A	Bond Class B	Bond Class C
Deal 2	2.90	5.86	7.87
Deal 1	3.48	7.49	11.19

Table 12.7 Monthly cash flow for selected months for bond classes A and B in Deal 2 assuming 165 PSA

	Bond Class A			Bond Class B		
Month	Balance	Principal	Interest	Balance	Principal	Interest
1	194,500,000	1,166,173	1,215,625	36,000,000	0	225,000
2	193,333,827	1,280,997	1,208,336	36,000,000	0	225,000
3	192,052,829	1,395,531	1,200,330	36,000,000	0	225,000
4	190,657,298	1,509,680	1,191,608	36,000,000	0	225,000
5	189,147,619	1,623,350	1,182,173	36,000,000	0	225,000
6	187,524,269	1,736,446	1,172,027	36,000,000	0	225,000
7	185,787,823	1,848,875	1,161,174	36,000,000	0	225,000
8	183,938,947	1,960,543	1,149,618	36,000,000	0	225,000
9	181,978,404	2,071,357	1,137,365	36,000,000	0	225,000
10	179,907,047	2,181,225	1,124,419	36,000,000	0	225,000
11	177,725,822	2,290,054	1,110,786	36,000,000	0	225,000
12	175,435,768	2,397,755	1,096,474	36,000,000	0	225,000
60	15,023,406	3,109,398	93,896	36,000,000	0	225,000
61	11,914,007	3,091,812	74,463	36,000,000	0	225,000
62	8,822,195	3,074,441	55,139	36,000,000	0	225,000
63	5,747,754	3,057,282	35,923	36,000,000	0	225,000
64	2,690,472	2,690,472	16,815	36,000,000	349,863	225,000
65	0	0	0	35,650,137	3,023,598	222,813
66	0	0	0	32,626,540	3,007,069	203,916
67	0	0	0	29,619,470	2,990,748	185,122
68	0	0	0	26,628,722	2,974,633	166,430
69	0	0	0	23,654,089	2,958,722	147,838
70	0	0	0	20,695,367	2,943,014	129,346
71	0	0	0	17,752,353	2,927,508	110,952
72	0	0	0	14,824,845	2,912,203	92,655
73	0	0	0	11,912,642	2,897,096	74,454
74	0	0	0	9,015,546	2,882,187	56,347
75	0	0	0	6,133,358	2,867,475	38,333
76	0	0	0	3,265,883	2,852,958	20,412
77	0	0	0	412,925	412,925	2,581
78	0	0	0	0	0	0

The reason for the shortening of the three nonaccrual bond classes is that the interest that would have been paid to the accrual bond class is being allocated to the other bond classes. Bond class Z in Deal 2 will have a longer average life than that of bond class D in Deal 1. Thus, shorter-term bond classes and a longer-term bond class are created by including an accrual bond.

The accrual bond has appeal to investors who are concerned with reinvestment risk. Because there are no coupon payments to reinvest, reinvestment risk is eliminated until all the other bond classes are paid off.

Floating-Rate Bond Classes

Floating-rate bond classes can be created from fixed-rate bond classes by creating a floater and an inverse floater. We illustrate the creation of a floating-rate bond class and an inverse-floating-rate bond class using the hypothetical CMO structure Deal 2, which is a sequential-pay structure with an accrual bond. We can select any of the bond classes from which to create a floating-rate and an inverse-floating-rate bond class.

For our illustration, we will create a floater and an inverse floater from bond class C. The par value for this bond class is \$96.5 million, and we create two bond classes that have a combined par value of \$96.5 million. We refer to this CMO structure with a floater and an inverse floater as Deal 3. It has five bond classes (A, B, FL, IFL, and Z), where FL is the floating-rate bond class and IFL is the inverse-floating-rate bond class. Table 12.8 is the prospectus supplement for Deal 3. Any reference rate can be used to create a floater and the corresponding inverse floater. The reference rate for setting the coupon rate for FL and IFL in Deal 3 is 1-month LIBOR. The par value of the floating-rate bond class will be some portion of the par value of bond class C, \$96.5 million. The decision by the structurer of how to partition bond class C's par value will be driven by investor demand. In Deal 3, the floater will have a par value of \$72,375,000 or 75% of the \$96.5 million. The coupon rate on the floater is set at 1-month LIBOR plus 50 basis points. The coupon rate on the floater must have a maximum coupon rate or "cap" for the reason explained later.

The principal payments to the floater are determined by the principal payments from the bond class from which the floater is created. In our CMO structure, this is bond class C.

Because the floater's par value is \$72,375,000 of the \$96.5 million, the balance is the inverse floater's par value. Assuming that 1-month LIBOR is the reference rate, the coupon rate on the inverse floater takes the following form:

$$K - L \times (\text{1-month LIBOR})$$

In Deal 3, K is set at 28.50% and L at 3. That is, the coupon rate for the month is:

$$28.50\% - 3(\text{1-month LIBOR})$$

K is the cap or maximum coupon rate for the inverse floater.

In Deal 3, the cap for the inverse floater is 28.50%. The L or multiple in the formula to determine the coupon rate for the inverse floater is called the *coupon leverage*. The higher the coupon leverage, the more the inverse floater's coupon rate changes for a given change in 1-month LIBOR.[2]

[2] Participants refer to low-leverage inverse floaters as those with a coupon leverage between 0.5 and 2.1; medium-leverage as those with a coupon leverage higher than 2.1 but not exceeding 4.5; and high-leverage as those with a coupon leverage higher than 4.5.

Table 12.8 Prospectus supplement for Deal 3

BOND CLASSES

Bond Class	Par Amount	Coupon Rate (%)
A	$194,500,000	7.50
B	36,000,000	7.50
FL	72,375,000	1-month LIBOR + 0.50
IFL	24,125,000	28.50 – 3 (1-month LIBOR)
Z (accrual)	73,000,000	7.50
	$400,000,000	

Rules for Distribution of Principal and Interest

1. *For payment of periodic coupon interest*: Disburse periodic coupon interest to bond classes A, B, FL, and IFL on the basis of the amount of principal outstanding at the beginning of the period. For bond class Z, accrue the interest based on the principal plus accrued interest in the preceding period. The interest for bond class Z is to be paid to the earlier bond classes as a principal paydown. The maximum coupon rate for FL is 10%; the minimum coupon rate for IFL is 0%.
2. *For disbursement of principal payments*: Disburse principal payments to bond class A until it is paid off completely. After bond class A is paid off completely, disburse principal payments to bond class B until it is paid off completely. After bond class B is paid off completely, disburse principal payments to bond classes FL and IFL until they are paid off completely. The principal payments between bond classes FL and IFL should be made in the following way: 75% to bond class FL and 25% to bond class IFL. After bond classes FL and IFL are paid off completely, disburse principal payments to bond class Z until the original principal balance plus accrued interest is paid off completely.

Here is how the interest is paid. The total interest to be paid to the two bond classes comes from the interest that would be paid to the bond class from which the two bond classes were created—bond class C in our illustration. The coupon rate for bond class C is 7.5%. The coupon rate formula for the floater can be derived and is:

1-month LIBOR + 0.50

Because the floater is 75% of the $96.5 million and the inverse floater is 25%, the weighted-average coupon rate is:

0.75 (floater coupon rate) + 0.25 (inverse floater coupon rate)

The weighted-average coupon rate is 7.5%, regardless of the level of LIBOR. For example, if 1-month LIBOR is 9%, then the floater coupon rate is 9.5% (= 9.0% + 0.5%) and for the inverse floater the coupon rate is 1.5% (= 28.5% − 3×9.0%). The weighted-average coupon rate is:

$$0.75(9.5\%) + 0.25(1.5\%) = 7.5\%$$

Consequently, the 7.5% coupon rate on the bond class from which these two classes were created can support the aggregate interest payments that must be made to them. As in the case of the floater, the principal paydown of an inverse floater will be a proportionate amount of the principal paydown of bond class C.

Because 1-month LIBOR is always positive, the coupon rate paid to the floater cannot be negative. In the absence of any restrictions on the coupon rate for the inverse floater, it is possible for the coupon rate for that bond class to be negative. To prevent this, a floor, or minimum, must be imposed on the coupon rate. Once a floor is set for the inverse floater, a cap is imposed on the floater. In Deal 3, a floor of zero is set for the inverse floater. The floor results in a cap for the floater of 10%.[3]

It should be noted that the cap for the floater and the inverse floater, the floor for the inverse floater, the coupon leverage, and the margin spread are not determined independently. Given four of these variables, the fifth will be determined.

Planned Amortization Bond Classes

A *planned amortization bond class* (or simply PAC) has a schedule of principal payments, reducing the prepayment risk compared to the bond classes discussed thus far.

To understand how this is done, suppose that the collateral prepays at any speed between 90 PSA and 300 PSA. The last column in Table 12.9 gives the minimum principal payment. For example, if we had included principal payment figures assuming a prepayment speed of 200 PSA, the minimum principal payment would not change. As can be seen, from month 11 through month 103, the minimum principal payment is that generated from 90 PSA, but from month 104 on, the minimum principal payment is that generated from 300 PSA.

Using this information about the collateral allows for the creation of a PAC bond, assuming that the collateral prepays over its life at a speed between 90 PSA to 300 PSA. A schedule of principal repayments that the PAC bondholders are entitled to receive before any other bond class in the CMO is specified. The monthly schedule of principal repayments is as specified in the last column of Table 12.9, which shows the minimum principal payment.

Of course, there is no assurance that the collateral will prepay between these two prepayment rates, but a PAC bond can be structured to assume that it will. Table 12.10 provides the prospectus supplement for Deal 4, created from the collateral in Table 12.2. Only two bond classes are in this structure: a 7.5% coupon PAC bond created assuming 90 to 300 PSA with a par value of $243.8 million, and a support bond (discussed later) with a par value of $156.2 million. The prepayment speeds used to create a PAC bond are

[3] This is found by substituting zero for the coupon rate of the inverse floater in the formula for the weighted-average coupon rate, and then setting the formula equal to 7.5%.

Table 12.9 Monthly principal payment for $400 million 7.5% coupon mortgage passthrough security at an 8.125% WAC and a 357 WAM assuming prepayment rates of 90 PSA and 300 PSA

Month	At 90% PSA	At 300% PSA	Minimum Principal Payment—the PAC Schedule
1	508,169.52	1,075,931.20	508,169.52
2	569,843.43	1,279,412.11	569,843.43
3	631,377.11	1,482,194.45	631,377.11
4	692,741.89	1,683,966.17	692,741.89
5	753,909.12	1,884,414.62	753,909.12
6	814,850.22	2,083,227.31	814,850.22
7	875,536.68	2,280,092.68	875,536.68
8	935,940.10	2,474,700.92	935,940.10
9	996,032.19	2,666,744.77	996,032.19
10	1,055,784.82	2,855,920.32	1,055,784.82
11	1,115,170.01	3,041,927.81	1,115,170.01
12	1,174,160.00	3,224,472.44	1,174,160.00
13	1,232,727.22	3,403,265.17	1,232,727.22
14	1,290,844.32	3,578,023.49	1,290,844.32
15	1,348,484.24	3,748,472.23	1,348,484.24
16	1,405,620.17	3,914,344.26	1,405,620.17
17	1,462,225.60	4,075,381.29	1,462,225.60
18	1,518,274.36	4,231,334.57	1,518,274.36
101	1,458,719.34	1,510,072.17	1,458,719.34
102	1,452,725.55	1,484,126.59	1,452,725.55
103	1,446,761.00	1,458,618.04	1,446,761.00
104	1,440,825.55	1,433,539.23	1,433,539.23
105	1,434,919.07	1,408,883.01	1,408,883.01
211	949,482.58	213,309.00	213,309.00
212	946,033.34	209,409.09	209,409.09
213	942,601.99	205,577.05	205,577.05
346	618,684.59	13,269.17	13,269.17
347	617,071.58	12,944.51	12,944.51
348	615,468.65	12,626.21	12,626.21
349	613,875.77	12,314.16	3,432.32
350	612,292.88	12,008.25	0
351	610,719.96	11,708.38	0
352	609,156.96	11,414.42	0
353	607,603.84	11,126.28	0
354	606,060.57	10,843.85	0
355	604,527.09	10,567.02	0
356	603,003.38	10,295.70	0
357	601,489.39	10,029.78	0

Table 12.10 Prospectus supplement for Deal 4

BOND CLASSES		
Bond Class	Par Amount	Coupon Rate (%)
P (PAC)	$243,800,000	7.5
S (Support)	156,200,000	7.5
	$400,000,000	

Rules for Distribution of Principal and Interest

1. *For payment of periodic coupon interest*: Disburse periodic coupon interest to each bond class on the basis of the amount of principal outstanding at the beginning of the period.
2. *For disbursement of principal payments*: Disburse principal payments to bond class P based on its schedule of principal repayments. Bond class P has priority with respect to current and future principal payments to satisfy the schedule. Any excess principal payments in a month over the amount necessary to satisfy the schedule for bond class P are paid to bond class S. When bond class S is paid off completely, all principal payments are to be made to bond class P regardless of the schedule.

called the *initial PAC bands*; in our illustration, 90 PSA is the lower band and 300 PSA is the upper band.

The average life for the PAC bond and the support bond in Deal 4 assuming various actual prepayment rates is given in Table 12.11. Notice that between 90 PSA and 300

Table 12.11 Average life for PAC bond and support bond in Deal 4 assuming various prepayment speeds

Prepayment Rate (PSA)	PAC Bond (P)	Support Bond (S)
0	15.97	27.26
50	9.44	24.00
90	7.26	18.56
100	7.26	18.56
150	7.26	12.57
165	7.26	11.16
200	7.26	8.38
250	7.26	5.37
300	7.26	3.13
350	6.56	2.51
400	5.92	2.17
450	5.38	1.94
500	4.93	1.77
700	3.70	1.37

PSA, the average life for the PAC bond is stable at 7.26 years. However, at slower or faster PSA prepayment rates, the schedule is broken, and the average life changes, lengthening when the prepayment speed is less than 90 PSA and shortening when it is greater than 300 PSA. Even so, there is much greater variability for the average life of the support bond.

Series of PAC Bonds

Table 12.12 is the prospectus supplement for Deal 5 that includes six PAC bonds and one support bond. The PAC bonds pay off in sequence. The total par value of the six PAC bonds is equal to $243.8 million, which is the amount of the single PAC bond in Deal 4.

Table 12.13 shows the average life for the six PAC bonds and the support bond in Deal 5 at various prepayment rates. From a PAC bond in Deal 4 with an average life of 7.26 years, we have created six bonds with an average life as short as 2.58 years (P-A) and as long as 16.92 years (P-F) if prepayments stay within 90 PSA and 300 PSA.

As can be seen in Table 12.13, the average lives are stable if the realized prepayment rate is between 90 PSA and 300 PSA. Even outside of this range it can be seen that the average life is stable for several of the shorter PAC bonds. For example, the PAC P-A

Table 12.12 Prospectus supplement for Deal 5

BOND CLASSES		
Bond Class	Par Amount	Coupon Rate (%)
P-A	$85,000,000	7.5
P-B	8,000,000	7.5
P-C	35,000,000	7.5
P-D	45,000,000	7.5
P-E	40,000,000	7.5
P-F	30,800,000	7.5
S	156,200,000	7.5
	$400,000,000	

Rules for Distribution of Principal and Interest

1. *For payment of periodic coupon interest*: Disburse periodic coupon interest to each bond class on the basis of the amount of principal outstanding at the beginning of the period.
2. *For disbursement of principal payments*: Disburse principal payments to bond classes P-A to P-F based on their respective schedules of principal repayments. Bond class P-A has priority with respect to current and future principal payments to satisfy the schedule. Any excess principal payments in a month over the amount necessary to satisfy the schedule for bond class P-A are paid to bond class S. When bond class P-A is paid off completely, bond class P-B has priority, then bond class P-C, and so on. When bond class S is paid off completely, all principal payments are to be made to the remaining PAC bond classes in order of priority regardless of the schedule.

Table 12.13 Average life for the six PAC bonds in Deal 5 assuming various prepayment rates

Prepayment Rate (PSA)	PAC Bonds					
	P-A	P-B	P-C	P-D	P-E	P-F
0	8.46	14.61	16.49	19.41	21.91	23.76
50	3.58	6.82	8.36	11.30	14.50	18.20
90	2.58	4.72	5.78	7.89	10.83	16.92
100	2.58	4.72	5.78	7.89	10.83	16.92
150	2.58	4.72	5.78	7.89	10.83	16.92
165	2.58	4.72	5.78	7.89	10.83	16.92
200	2.58	4.72	5.78	7.89	10.83	16.92
250	2.58	4.72	5.78	7.89	10.83	16.92
300	2.58	4.72	5.78	7.89	10.83	16.92
350	2.58	4.72	5.49	6.95	9.24	14.91
400	2.57	4.37	4.91	6.17	8.33	13.21

bond is stable even if prepayment rates realized are as high as 400 PSA. For the PAC P-B bond, the average life does not vary when prepayments are in the initial PAC band until prepayments exceed 350 PSA. This means that these bond classes have greater prepayment protection than suggested by the initial PAC bands.

To understand why the shorter PAC bonds have more prepayment protection, look at the support bond. In Deal 5 there are \$156.2 million in support bonds that are protecting the \$85 million of PAC P-A. Consequently, even if prepayment rates are faster than the initial upper PAC band, there may be sufficient support bonds to assure the satisfaction of the PAC schedule for the PAC P-A bond. In fact, as can be seen from Table 12.13, even if the prepayment rate realized is 400 PSA over the life of the collateral, the average life for the PAC P-A bond is unchanged.

Let's look at the PAC P-B bond. The support bond is providing prepayment protection for both the \$85 million of the PAC P-A bond and \$93 million of the PAC P-B bond. As can be seen from Table 12.13, even if a 350 PSA prepayment rate is realized, the average life is unchanged.

Another take away from the average lives reported in Table 12.13 is that the degree of protection against extension risk increases the shorter the PAC. Thus, whereas the initial PAC band may be 90 to 300 PSA, the band is wider for the shorter PAC bond classes. This PAC band for which the average life remains stable for a bond class is referred to as the *effective collar*. The effective collar for the six PAC bond classes in Deal 5 is shown in Table 12.14.

As has been emphasized, the creation of an MBS cannot make prepayment risk disappear. This is true for both a mortgage passthrough security and a CMO. Thus, the reduction in prepayment risk (both extension risk and contraction risk) that a PAC offers must come from somewhere. Prepayment protection comes from the support bonds. It is the support bonds that forgo principal payments if the collateral prepayments are

Table 12.14 Effective collars for the PAC bonds in Deal 5

Amount of Support Bonds: $156.2 Million	
Bond Class	Effective Collar
P-A	90–450 PSA
P-B	90–350 PSA
P-C	90–300 PSA
P-D	90–300 PSA
P-E	90–300 PSA
P-F	90–300 PSA

slow; support bonds do not receive any principal until the PAC bonds receive the scheduled principal repayment. This reduces the risk that the PAC bonds will extend.

Similarly, it is the support bonds that absorb any principal payments in excess of the scheduled principal payments that are made, thereby reducing a PAC bond's exposure to contraction risk. For this reason, the key to a PAC bond's prepayment protection is the amount of support bonds outstanding. If the support bonds are paid off quickly because of faster-than-expected prepayments, there is no longer any prepayment protection for the PAC bonds. In fact, in Deal 5, if the support bond is paid off, the structure is effectively reduced to a sequential-pay CMO.

Investors in PAC bonds must typically ask two questions. First, will the schedule of principal repayments be satisfied if prepayments are faster than the initial upper collar? Second, will the schedule of principal repayments be satisfied as long as prepayments stay within the initial collar?

Let's address the first question. The short answer is: it depends. To answer this question, an investor needs two pieces of information: (1) when do the faster-than-expected prepayment rates occur, and (2) what has been the actual prepayment experience up to the time that the faster-than-expected prepayment rates occur. For example, consider Deal 5. Suppose that six years from now there is a spike in prepayments such that the prepayment rate is 500 PSA. Also suppose that for the past six years the actual prepayment speed has been 90 PSA every month. This means that there are more support bonds to provide prepayment protection for PAC bonds than was expected when the PAC was structured at the initial PAC band. In establishing the schedule of principal repayments, it was assumed that the support bonds would be paid down at 300 PSA, but the actual prepayment experience results in the support bonds being paid off at only 90 PSA. Thus, six years from now when the 500 PSA is assumed to occur, there are more support bonds than expected. Thus, a 500 PSA for seven consecutive months may have no effect on the ability of the schedule of principal repayments to be met.

In contrast, suppose that the actual prepayment experience for the first six years is 300 PSA (the upper PAC band). In this case, there are no extra support bonds around to provide prepayment protection to the PAC bonds. As a result, prepayment rates faster than 300 PSA, such as 500 PSA in our example, jeopardize satisfaction of the principal repayment schedule and increase extension risk. This does not mean that the schedule will be busted—the term used in the CMO market when a PAC schedule is broken. However, it does mean that the prepayment protection is reduced.

An important takeaway from the above discussion is that in looking at the prepayment protection of a seasoned PAC bond, the initial PAC band is not particularly useful. Consequently, it would be a mistake for an investor to compare prepayment protection of PACs in different CMO structures and conclude that the greater prepayment protection is offered by the one with the wider collar. The pitfall of comparing initial PAC bands for PAC bonds across CMO deals is that it is actual prepayment experience that determines the degree of prepayment protection going forward as well as the collateral's expected future prepayment behavior.

The proper way to assess future prepayment protection for a seasoned PAC bond is to calculate the lower and upper prepayment rates that can occur and still be able to satisfy the PAC schedule.[4] This lower and upper band is also referred to as the effective collar. We have used the term "effective collar" twice: first when we discussed the effective collar for a series of PAC bonds and now for a seasoned PAC bond based on actual prepayment experience.

It is important to bear in mind that the PAC schedule may not be satisfied even if the actual prepayments never fall outside the initial PAC band. This may seem surprising because our previous analysis indicated that the average life would not change if prepayments are at either extreme of the initial collar. However, recall that all of our previous analysis has been based on a single PSA speed for the life of the structure. To illustrate this, we will use multiple prepayment rates that the collateral may experience. Table 12.15

Table 12.15 Average life two years from now for PAC bond in Deal 4 assuming prepayments of 300 PSA for first 24 months

PSA from Year 2 on	Average Life (years)
95	6.43
105	6.11
115	6.01
120	6.00
125	6.00
300	6.00
305	5.62

[4] Investors typically do not perform this calculation to obtain the effective collar. Analytical systems provide these values.

shows the average life two years from now for the PAC bond in Deal 4, assuming that prepayment rates are 300 PSA for the first 24 months. Notice that the average life is stable at six years if the prepayments for the following months are between 115 PSA and 300 PSA. That is, the effective PAC collar is no longer the initial collar. Instead, the lower collar has shifted upward. This means that the protection from year 2 on is for 115 to 300 PSA, a narrower band than initially even though the earlier prepayments did not exceed the initial upper collar.

Variations in PAC Bond Classes

What we have described thus far in this section is the basic PAC bond. There are variations of the basic PAC bond designed to offer investors in PAC bonds greater prepayment protection.

One obvious way to provide greater protection for PAC bonds is to issue fewer PAC bonds relative to support bonds. In Deal 5, for example, rather than creating the six PAC bonds with a total par value of $243.8 million, the structurer could use only $158.8 million of the $400 million of collateral to create these bonds by reducing the amount of each of the six PAC bonds. An alternative is not to issue one of the PAC bonds, typically the shorter-term one. For example, suppose that we create only the last five of the six PAC bonds in Deal 5. The $85 million for PAC P-A is then used to create more support bonds. Such a CMO structure with no principal payments to a PAC bond class in the earlier years is referred to as a *lockout structure*.

A lockout structure provides greater prepayment protection to all PAC bonds in the CMO structure. One way to provide greater prepayment protection to only some PAC bonds is to alter the principal payment rules for distributing principal when all the support bonds have been paid off. In Deal 5, for example, when the support bond in this structure is paid off, the structure effectively becomes a sequential-pay structure. For PAC P-A in Deal 5, this means that although there is protection against extension risk, as this bond class receives principal payments before the other five PAC bonds, there is no protection against contraction.

To provide greater protection to PAC P-A, the payment rules after all support bonds have been paid off can be specified so that any principal payments in excess of the scheduled amount will be paid to the last PAC bond, P-F. Thus, PAC P-F is exposed to greater contraction risk, which provides the other five PAC bonds with more protection against contraction risk. The principal payment rules would also specify that when the support bond and PAC P-F bond are paid off, all principal payments in excess of the scheduled amounts to earlier bond classes are to be paid to the next-to-last PAC bond, PAC P-E in our example. A CMO structure requiring any excess principal payments to be made to the longer PAC bonds after all support bonds are paid off is called a *reverse PAC structure*.

Targeted Amortization Class Bonds

There is another type of bond class that like a PAC bond has a schedule for the repayment of principal, a *targeted amortization class* (TAC). However, this bond class differs from a PAC bond in that while a PCA bond has a wide PSA range over which the schedule of principal repayment is protected against contraction risk and extension risk, a TAC bond has a single PSA rate from which the schedule of principal repayment is protected. Consequently, the resulting prepayment protection for an investor in a TAC bond is less than that for an investor in a PAC bond. More specifically, there is prepayment protection against contraction risk but not extension risk. For this reason, it is said that a PAC bond provides two-sided prepayment protection while a TAC bond has one-sided prepayment protection.

There are TAC bonds that provide prepayment protection against extension risk but not contraction risk. A TAC bond with this form of prepayment protection is called a *reverse TAC bond*.

Very Accurately Determined Maturity Bonds

Earlier we described accrual or Z bonds and we saw how they have been used in CMO structures to create shorter-term bond classes. They also have been used in CMO structures as support for bonds called *very accurately determined maturity* (VADM) or *guaranteed final maturity bonds*. This is done by using the interest accruing on a Z bond to pay the interest and principal on a VADM bond. By doing so, this effectively provides prepayment protection against extension risk even if the prepayment rates slow down, because the interest accruing on the Z bond will be sufficient to pay off the scheduled principal and interest on the VADM bond. Consequently, the maximum final maturity can be determined with a high degree of certainty. If prepayments are high, resulting in the supporting Z bond being paid off faster, however, a VADM bond can shorten.

A VADM is similar in character to a reverse TAC. For structures with similar collateral, however, a VADM bond offers greater protection against extension risk. Because most VADMs are structured such that they will not shorten significantly if prepayments speed up, they offer greater protection against contraction risk compared to a reverse TAC with the same underlying collateral. When compared to PAC bonds, VADM bonds have greater absolute protection against extension risk, and although VADM bonds do not have as much protection against contraction risk, as noted previously, the structures that have included these bonds are such that contraction risk is generally not significant.

Interest-Only and Principal-Only Bond Classes

As we explain in Chapter 18, stripped mortgage-backed securities are created by paying all the principal to one bond class and all the interest to another bond class. These two classes are referred to as the *principal-only* (PO) *bond class* and the *interest-only* (IO) *bond class*. CMO structures can be created so that a bond class can receive only the principal or only the interest. For example, consider Deal 1. Bond class B in this structure can be divided into two bond classes, a PO bond class and an IO bond class.

Notional Interest-Only

In our previous illustrations, we used a CMO structure in which all the bond classes have the same coupon rate (7.5%) and that coupon rate is the same as the collateral. In practice, the same coupon rate would not be given to each bond class. Instead, the coupon rate would depend on the term structure of interest rates and the average life of the bond class, among other things.

To deal with the excess of interest paid to the bond class as a result of having a lower coupon rate than the collateral, a bond class can be created that receives the excess coupon interest. This bond class is called a *notional IO bond class* and is also referred to as a *structured IO*.

To see how a notional IO is created, we will use Deal 6 whose prospectus supplement is shown in Table 12.16. Notice that this CMO structure differs from Deal 2 because the coupon rate varies by bond class and there is a bond class denoted IO. It is the IO bond class that is of interest here.

For Deal 5, the par value for the IO bond class is $52,566,666 and the coupon rate is 7.5%. This is an IO class, so there is no par amount. The amount shown is the amount on which the interest payments will be determined, not the amount that will be paid to investors in the IO bond class. For this reason, the principal is referred to as a *notional amount*.

Here is how the notional amount is determined. Consider bond class A. The par value is $194.5 million and the coupon rate is 6%. Because the collateral's coupon rate is 7.5%, the excess interest is 150 basis points (1.5%). Therefore, an IO bond class with a 1.5% coupon rate and a notional amount of $194.5 million can be created from bond class A. However, this is equivalent to an IO bond class with a notional amount of $38.9 million and a coupon rate of 7.5%.[5] Similarly, from bond class B with a par value of $36 million, the excess interest is 100 basis points (1%), and therefore an IO bond class with a coupon

[5] Mathematically, the notional amount is found as follows for Deal 6: Notional amount for 7.5% IO = (Par value of bond class × Excess interest rate)/0.075 where Excess interest rate = Collateral coupon rate − Bond class coupon rate.

Table 12.16 Prospectus supplement for Deal 6

Bond Class	Par Amount	Notional Amount	Coupon Rate (%)
A	$194,500,000		6.00
B	36,000,000		6.50
C	96,500,000		7.00
Z	73,000,000		7.25
IO		52,566,666	7.50
	$400,000,000		

Rules for Distribution of Principal and Interest

1. *For payment of periodic coupon interest*: Disburse periodic coupon interest to bond classes A, B, and C on the basis of the amount of principal outstanding at the beginning of the period. For bond class Z, accrue the interest based on the principal plus accrued interest in the preceding period. The interest for bond class Z is to be paid to the earlier bond classes as a principal paydown. Disburse periodic interest to the IO bond class based on the notional amount at the beginning of the period.
2. *For disbursement of principal payments*: Disburse principal payments to bond class A until it is paid off completely. After bond class A is paid off completely, disburse principal payments to bond class B until it is paid off completely. After bond class B is paid off completely, disburse principal payments to bond class C until it is paid off completely. After bond class C is paid off completely, disburse principal payments to bond class Z until the original principal balance plus accrued interest is paid off completely.

rate of 1% and a notional amount of $36 million can be created. But this is equivalent to creating an IO bond class with a notional amount of $4.8 million and a coupon rate of 7.5%. For the other two bond classes, C and Z, it can be shown that a 7.5% IO bond class equivalent is $6,433,333 and $2,433,333, respectively. Adding all of the notional amounts gives an IO bond class with a 7.5% coupon and a notional amount of $52,566,666, which is the notational amount shown in Table 12.16 for the IO bond class.

Support Bonds

Finally, we will discuss a bond class we have referred to earlier: support bonds. This bond class provides prepayment protection for the PAC bond classes. Consequently, they are exposed to the greatest level of prepayment risk. Because of this, investors must be particularly careful in assessing the cash flow characteristics of support bonds to reduce the likelihood of adverse portfolio consequences due to prepayments.

There are different types of support bond classes. All the types of bond classes we have discussed earlier in this chapter can be created from support bonds, including sequential-pay support bond classes, floater and inverse floater support bond classes, and accrual support bond classes. The support bond can even be used to create support bond classes with a schedule of principal repayments (i.e, support PAC bonds). In a CMO structure with a PAC bond and a support bond with a PAC schedule of principal repayments, the former is called a *PAC I bond* and the latter a *PAC II bond*. What is critical to bear in mind when considering an investment in a PAC II bond is that although it has more prepayment protection than a support bond class without a schedule of principal repayments, the prepayment protection is still less than that provided by a PAC I bond. That is, it is still a support bond class and not a PAC bond.

Key Points

- Agency CMOs are bond classes created by redirecting the cash flow of mortgage-related products (e.g., mortgage passthrough securities).
- To comply with tax provisions, CMOs are structured so as to meet the requirement for a Real Estate Mortgage Investment Conduit, and for this reason are referred to as REMICs.
- Although the creation of a CMO cannot eliminate prepayment risk, redirecting the collateral's cash flow (interest and principal) to different bond classes allows for the redistribution of the prepayment risk.
- The prospectus supplement of a CMO transaction includes rules for the distribution of interest and principal from the collateral to the bond classes included in the structure.
- By redirecting the principal (regularly scheduled and prepayments) to bond classes, securities can be created with a different average life than the collateral as well as different degrees of average life variability.
- In a sequential-pay structure, the principal payment rules are such that the bond classes are retired sequentially.
- The inclusion of an accrual bond class allows for the creation of bond classes that have shorter-term and longer-term average life bonds than in a sequential-pay CMO without the inclusion of an accrual bond class.
- A floating-rate and an inverse-floating-rate bond class can be created from a fixed-rate bond class in a CMO structure.
- A planned amortization bond class (PAC) allows for a further reduction in prepayment risk than that provided by sequential-pay bonds.
- The bonds included in a CMO structure that allow for the better protection for PAC bonds are the support bond classes.
- PAC bonds are created with an initial band for the prepayment rate, but as the collateral seasons, a better measure of prepayment risk is the effective collar.
- Even greater prepayment protection can be provided in various ways for some or all of the PAC bonds within a CMO structure by including a lockout and/or a reverse PAC structure.
- For a targeted amortization class (TAC) bond class, there is one-sided prepayment protection: protection against contraction risk but not extension risk.
- A reverse TAC provides one-sided protection: protection against extension risk but not against contraction risk.
- A very accurately determined maturity bond class provides prepayment protection against extension risk.

- A bond class can be carved up to create an interest-only and a principal-only bond class.
- By using the difference between the collateral's coupon interest and the total coupon interest paid to a bond class, a notional IO bond class can be created.
- The riskiest type of bond class in a CMO structure is a support bond class.
- Some of the support bonds can be carved up to create support bonds with a principal repayment schedule referred to as PAC II bonds.

CHAPTER 13

AGENCY PLANNED AMORTIZATION CLASS BONDS

WILLIAM IRVING, FRANK J. FABOZZI, AND LINDA LOWELL

After reading this chapter you will understand:

- what a planned amortization class (PAC) bond is;
- the appeal of PAC bonds to the different investor types;
- the investment features of PAC bonds;
- how a PAC bond is created in a collateralized mortgage obligation deal;
- the importance of PAC collars and collateral type;
- what is meant by a PAC collar drift and a PAC window;
- the two ways in which a lockout can be structured;
- how an accrual (Z) bond performs;
- the option costs associated with PAC features;
- how to evaluate a PAC bond.

Planned amortization class (PAC) bonds represent one of the largest sectors of the collateralized mortgage obligation (CMO) market. The main attraction of PAC bonds is that they provide a defined schedule of principal payments (or, similarly, target balances), which is guaranteed as long as prepayment speeds remain within a specified range. For example, the principal payments could be guaranteed for any fixed prepayment speed between 100% and 300% PSA. Hence the name for this bond class is "planned amortization." This structure means that PACs are insulated to a degree from the uncertainty regarding the cash flows of most MBS, which arises from the right of mortgage borrowers to prepay their loans at any time.

Prepayments generally increase when interest rates fall and decrease when interest rates rise. As a result, interest rates have a material impact on the average life, duration, and performance of mortgage securities. Specifically, passthroughs shorten when interest rates fall and extend when interest rates rise. To compensate investors for exposure to this behavior, passthroughs and other MBS are priced at higher yields than other, non callable bonds of similar credit quality (such as agency debt). PAC bonds partake of some of the incremental yield available in the MBS market while at the same time providing more certain cash flows (i.e., less exposure to prepayment risk).

To broaden investor appeal, a PAC can be cut up into a sequence of PACs having successively longer average lives. For example, the front PAC could take the first 24 months of scheduled principal payments, the next PAC could take the next 12 months of principal payments, and so forth. Different classes of investors will have different natural habitats. Typical PAC buyers tend to be asset–liability matchers such as life insurance companies (focusing on long PACs) and commercial banks (focusing on short ones). However, the PAC market can also appeal to investors with active bond management strategies. These investors may have, for instance, opinions about the direction of mortgage–Treasury spreads or mortgage–corporate spreads, they may wish to execute barbell or other strategies designed to take advantage of expectations regarding the level or shape of the yield curve, or they may be seeking value advantages, either between the PAC and other CMO sectors, or within the PAC sector, among PACs with different features.

As the PAC window of principal payments gets narrower, the bond becomes more bullet-like, and thus becomes a more natural substitute for corporate and/or Treasury securities. Such PACs can attract crossover buyers from the corporate-bond market, who get enticed by the nominal spreads, high credit quality, and reduced event risk.

This chapter is intended to serve both classes of investors—the buy-and-hold PAC buyer, who wants to partake of the attractive yields in the mortgage market but whose liabilities or actuarial requirements necessitate more stable cash flows than either passthroughs or other CMOs can provide, and the active portfolio manager. The chapter examines the different features of PAC bonds and their effect on market value and investment performance. Where it is possible to isolate a specific characteristic, an attempt is made to model and examine its impact on the average life and yield behavior of the bond, as well as on its theoretical or option-adjusted value.

The Term Structure of CMO Yields

The yields that investors require for occupying different average-life sectors of the PAC market are determined by the same factors that influence other fixed-income investors: portfolio objectives and constraints, the current and anticipated shape of the yield curve, expectations regarding the underlying monetary and economic determinants of interest rates, and so forth. In addition, PAC buyers require additional yield as they extend the maturity of their investments to compensate them for the increased risk that prepayment speeds fall outside of the specified range for the PAC, which can lead to average-life variability. Figure 13.1 depicts the range of possible average lives for each PAC in a sequence of PACs in a single CMO deal. The range gradually widens to its widest point among the intermediate-term PACs.

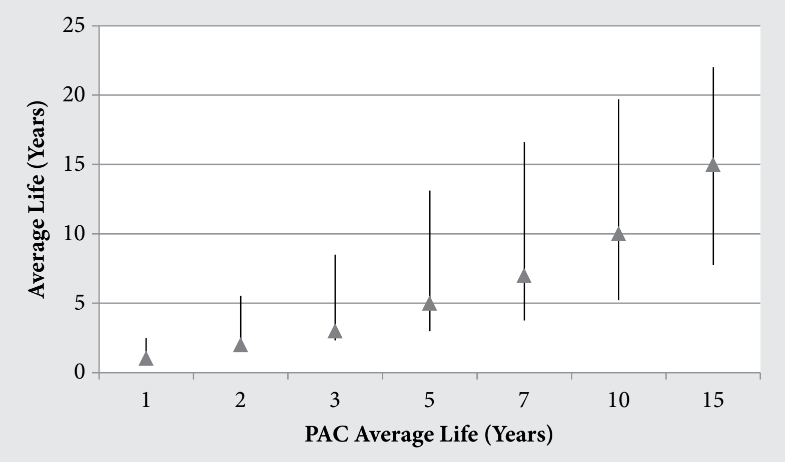

FIGURE 13.1 Range of possible average lives for each of a series of PACs as prepayment speeds vary from 0% to 600% PSA

Note: The triangles indicate the scheduled average life

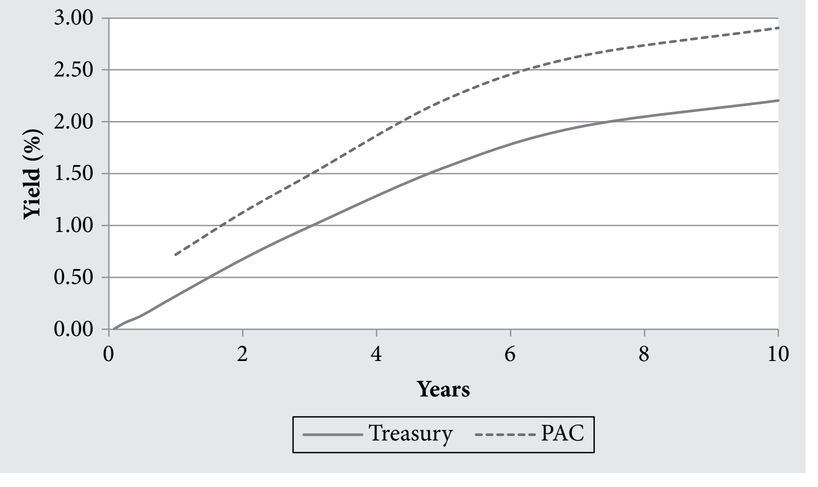

FIGURE 13.2 Term structure of yields for US Treasuries and PACs (as of July 31, 2015)

Figure 13.2 illustrates the term structure of yields for generic PACs backed by current-coupon conventional collateral and for on-the-run Treasuries as of July 31, 2015. CMO spreads are influenced by the same factors that affect passthrough spreads—volatility of market yields, prepayment expectations, supply of new product, and so forth. Normally CMO spreads track passthrough spreads, with the relationship enforced by the existence of CMO arbitrage opportunities. When passthroughs cheapen relative to CMOs, new transactions are marketed, increasing the supply of CMOs and ultimately allowing CMOs to cheapen relative to passthroughs, thereby reducing the arbitrage opportunity.

Other features of the structure such as the collateral coupon, the PAC's coupon, the collars, and the window result in additional adjustments to the required yields. In addition, the cash flow performance of the bond outside the collars is affected by other characteristics, such as whether its schedule is supported by accrual from a longer-term Z bond later in the structure, and its priority for receiving excess cash flow. These characteristics determine how volatile its average life and return are outside the collars, and so also affect the marketability of a PAC bond.

Mechanics of Defining Collars and Payment Schedule

To define a PAC schedule, one begins by specifying the range of prepayment speeds over which the principal payments should remain stable. For example, the range might be 100% to 300% PSA. The lower speed (in this case, 100% PSA) is known as the lower collar, while the upper speed (300% PSA) is known as the upper collar. The next step is to project the principal paydowns from the given collateral at the two speeds. For each date, the PAC scheduled amount is set equal to the minimum of the projected

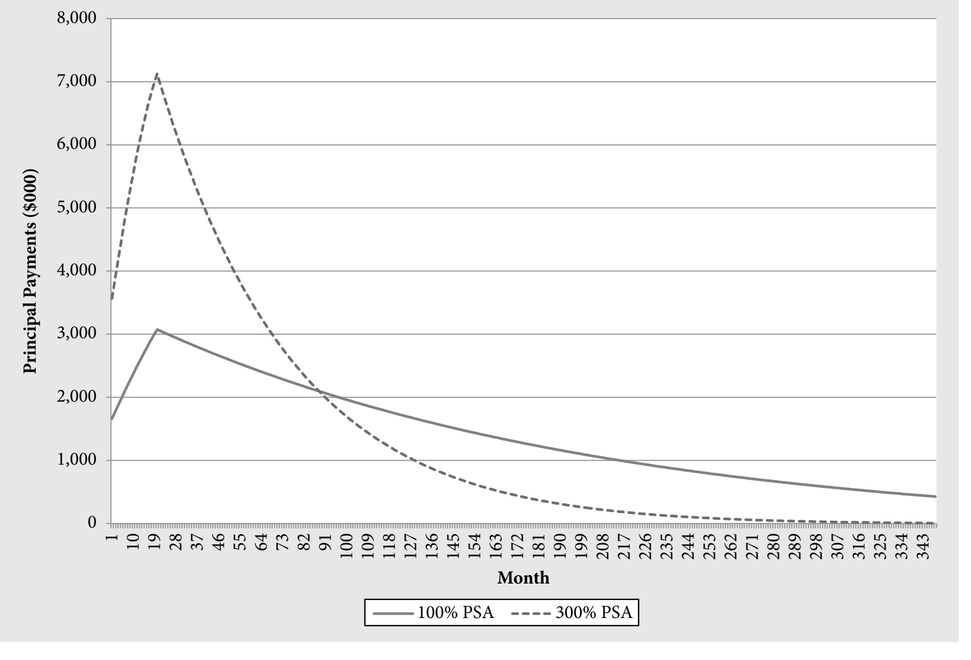

FIGURE 13.3 Projected principal paydowns on $500 million FNMA 3.5s (4.202 WAC and 349 WAM) at speeds of 100% and 300% PSA

Table 13.1 Effective bottom and top collars for a seven-tranche PAC constructed off FNMA 3.5s (4.202 WAC, 349 WAM) with collars of 100% and 300% PSA

	Effective Collar	
PAC Average Life	Bottom	Top
1	100	650
3	100	340
5	100	310
7	100	300
10	100	300
15	82	300
23	20	300

paydowns at the high and low speeds. Figure 13.3 illustrates this approach using $500 million FNMA 3.5s with a 4.202 WAC and a 349-month WAM[1] and using collars of 100% to 300% PSA.

The faster speed (300% PSA) results in a cash flow pattern with the bulk of the principal thrown off during the first five to seven years of the issue's life. The slower speed (100% PSA) produces a more level set of smaller cash flows extending to the final maturity of the collateral. The intersection of these two sets of payments forms the schedule. In the example, the bottom collar determines the payment amounts during the first 100 or so months of the schedule, and the top collar the amounts in the remaining months.

The graph of any speed between the top and bottom collars would also contain the area of the schedule below it. The graph of any speed faster than the top collar would bunch more principal in the first years and truncate the tail of the schedule in front of the point where the top and bottom collars intersect. Similarly, the graph of any speeds slower than the bottom collar would reduce the size of paydowns in the front years. At very slow speeds, most of the principal payments are pushed into the back years.

Once the scheduled principal payments are defined at given collars, the PAC schedule may be further divided into classes with different average lives. The so-called effective collar of any of these tranches is the highest (or lowest) constant prepayment speed that would satisfy the entire tranche's payments, while not paying down the support tranche. Table 13.1 quantifies the effective bottom and top collars for a seven-tranche PAC constructed off FNMA 3.5s having a 4.202% weighted-average coupon (WAC), a 349-month weighted-average maturity (WAM), with collars of 100% and 300% PSA. For instance, speeds up to 650% PSA will contain the first tranche in this example without extinguishing the support. Thus, this first tranche's effective top collar is 650% PSA.

[1] The scheduled amortization for the collateral is determined by the WAC and WAM.

Likewise, the lower collar of 100% PSA does not fully indicate the degree of extension protection that the longer average-life bonds, tranches 6 and 7, actually possess. Speeds below 100% PSA throw off principal too slowly to satisfy the scheduled payments in the early PAC tranches, but they provide more cash than needed to meet payments after about month 100, where the upper collar binds the schedule. For example, the effective bottom collar on tranche 7 is 20% PSA.

The standard speeds used to create PAC schedules may represent the market's aggregate opinion of what constitutes a "good" collar; however, investors should translate the PSA collars into interest rate collars by using a prepayment model to determine how much interest rates must shift to break the collars. Once the collar speeds are explicitly linked to interest rate shifts, investors can determine if the collar does deliver "good" protection over the scenarios appropriate to the investor's outlook and portfolio.

Collars and Collateral

The strength of the collars—whether they will be broken by actual prepayment experience—should be investors' primary concern. The strength is only nominally indicated in the differential between the top and bottom collar speeds. This range must be related to the specific collateral to gauge the strength of the protection provided. The type of collateral—the agency, the differential between current mortgage rates and the mortgage rates on the underlying loans, seasoning of the loans, loan balance, credit quality, loan-to-value ratio, and the degree to which the pools have prepaid in the past—determines how quickly or slowly the collateral will prepay in different interest rate scenarios. The collars simply define a range of prepayment speeds over which the PAC payments will not vary. When prepayments fall outside the collars, payments to the PAC holders may be either delayed or accelerated (the collars could be broken temporarily without affecting the payment schedule). A given set of PAC collars will provide stronger or weaker protection, depending on the collateral. For example, a top collar of 300% PSA provides greater call protection should interest rates decline if the collateral is a current coupon than if it is a premium coupon. Similarly, a bottom collar of 100% PSA provides better protection from extension if the collateral is a conventional passthrough than if the collateral is assumable FHA loans (in a GNMA).

All else being equal, PAC bonds backed by premium-coupon collateral do exhibit greater average-life variability than PACs backed by current-coupon collateral. This is illustrated by the comparison in Table 13.2, which displays the average lives at different prepayment speeds of two series of PACs, one backed by FNMA 3s (3.753 WAC, 355 WAM) and scheduled at 85% to 300% PSA, the other backed by FNMA 4.5s (4.862% WAC, 349-month WAM) and scheduled at 95% to 350% PSA.

Table 13.2 Average lives at different prepayment speeds of two series of PACs, one backed by FNMA 3s (3.753% WAC, 355 WAM) and scheduled at 85% to 300% PSA, the other backed by FNMA 4.5s (4.862% WAC, 349 WAM) and scheduled at 95% to 350% PSA

Prepayment Speed (% PSA)	FNMA 3% Collateral (85%–300% PSA Collars)							FNMA 4.5% Collateral (100%–350% PSA Collars)						
	1-Yr	2-Yr	3-Yr	5-Yr	7-Yr	10-Yr	15-Yr	1-Yr	2-Yr	3-Yr	5-Yr	7-Yr	10-Yr	15-Yr
0	1.98	4.49	7.25	11.72	15.22	18.55	21.09	2.93	6.27	9.22	13.72	17.04	19.63	21.34
50	1.21	2.44	3.83	6.55	9.16	12.29	15.35	1.42	2.90	4.49	7.53	10.37	13.13	15.45
85	1.00	2.00	3.00	5.00	7.00	10.00	15.00	1.10	2.18	3.31	5.55	7.75	10.32	15.00
100	1.00	2.00	3.00	5.00	7.00	10.00	15.00	1.00	2.00	3.00	5.00	7.00	10.00	15.00
300	1.00	2.00	3.00	5.00	7.00	10.00	15.00	1.00	2.00	3.00	5.00	7.00	10.00	15.00
350	1.00	2.00	3.00	4.80	6.21	8.74	13.15	1.00	2.00	3.00	5.00	7.00	10.00	15.00
400	1.00	2.00	3.00	4.38	5.54	7.77	11.66	1.00	2.00	3.00	4.66	6.17	8.80	13.25
450	1.00	2.00	2.93	3.98	5.00	6.98	10.45	1.00	2.00	2.94	4.19	5.51	7.84	11.81
600	1.00	2.00	2.54	3.16	3.90	5.33	7.87	1.00	1.98	2.44	3.19	4.14	5.84	8.75

PAC Collar Drift

The effective collars simply express the highest and lowest constant prepayment speeds at which the given collateral can continue to meet the scheduled prepayments. Unless the collateral prepays at precisely the collar speed (and then it can match only one, the upper or the lower collar speed), it will have a different balance than was projected when the schedule was defined. Likewise, the amount of support bonds (and proportion of support bonds to PACs) will be different. Prepayment rates below the top collar cause the collar to shift upward over time (as there is a greater amount outstanding than anticipated), whereas the collar is lowered if prepayments are higher. Likewise, prepayments above the bottom collar cause it to rise. Short- and intermediate-term PACs are affected differently by speeds below the collar than are long-term PACs at the end or tail of the schedule. Very slow speeds cause the collar to drift up in the earlier tranches, while speeds below the bottom collar can improve the extension protection of long PACs. Prepayment rates somewhere between the top and bottom collars—historically, the common occurrence—cause the effective prepayment protection to widen as the top collar changes more quickly than the bottom collar (unless prepayments are very near the top collar).

When the PAC Breaks

Breaking a PAC's schedule and causing it to be partially called or extended are not necessarily negative events for the bond's economic performance. The bond's coupon relative to market yields (or the bond's price relative to parity[2]) determines the effect prepayments outside the collar have on the realized yield or total return.

A PAC with a discount coupon may benefit if the upper collar is broken, returning principal at par earlier than anticipated at pricing. Similarly, the extension caused by breaking the lower collar adversely affects the performance of a discount-coupon PAC. In the case of a premium-coupon PAC, it benefits performance when the bottom collar is broken, since the principal remains outstanding longer than anticipated, earning additional coupon interest. And of course, the higher the coupon is, the worse the effect of breaking the top collar.

The shape of the yield curve is also a consideration. Extension can be costly in a steep yield curve; discounting a bond's cash flows at a sharply higher yield can offset any value additional coupon income might have. Likewise, the capital gain from rolling down a steep curve can offset the loss of coupon income.

[2] The delay in passing payments through to investors from the mortgage borrowers lowers the yield slightly for any given price because the cash flows are pushed out into the future. Different prepayment speeds do not change the yield if a bond is purchased at the parity price (slightly below 100), which adjusts par for the payment delay.

As collars deteriorate and approach a point where they may be broken, the market pays increasing attention to the average-life profile. A PAC may no longer have measurable effective collars but may still have a stable average life over a reasonable range of prepayment rates.

Windows

A PAC "window" is the interval over which scheduled principal payments are made to the bondholder. As long as prepayment speeds remain at a constant speed within the upper and lower protection bands, or PAC collars, the dates of the first and last principal payments (and equivalently, the length of the repayment period) are certain. PAC buyers in general prefer tighter windows. The chief benefit of a tight window is the superior roll down the yield curve it provides as the bond ages. Ideally the average life declines by a year for every year the bond is outstanding (assuming a stable yield and prepayment scenario).

Beyond rolldown considerations, the preference for tight windows reflects the practicalities of portfolio management. The match between a single liability and a single asset is easier to conceptualize when payments are concentrated over a short period. They also are easier to convert to floating-rate assets with swaps. A shorter window also means fewer and larger repayments. Tighter windows producing a more bullet-like paydown are, conceptually, better substitutes for corporates.

Generally, a tighter window is a greater consideration the longer the average life of the bond. Shorter-term PACs inherently have shorter windows, while the desire for tight windows in the 20-year sector is difficult to satisfy, owing to the "tailish" nature of the cash flows in the later years of the transaction. That is, the principal payments scheduled for the later years are relatively small in any month. This is easily confirmed by glancing at Figure 13.3. Carving the "tail" into shorter windows would result in more classes with odd, less marketable average lives.

Though there may be many reasons to prefer a tight window, Table 13.3 illustrates that window width has only a negligible effect on a PAC's average-life variability. The table quantifies the average-life variability for 5-year and 10-year PACs having various window widths (e.g., widths of 0.5 years, two years, and four years for the five-year PAC). All of these PACs have collars of 100% and 300% PSA and were constructed off FNMA 3.5s (4.202 WAC, 349 WAM). Even at fairly extreme prepayment speeds (0% and 600% PSA, for instance), there is little difference in the average lives of otherwise comparable PACs with different windows.

All else equal, as a result of their slightly wider spreads, PACs with average or wide windows should outperform those with tight windows. This result suggests that investors who do not require a bullet-like repayment of their investment, but rather can accommodate greater payment dispersion, should not discriminate between window

Table 13.3 Average-life variability for 5-year and 10-year PACs having various window widths

Prepayment Speed (% PSA)	Average Life (Years)					
	5-Year PAC			10-Year PAC		
	0.5	2	4	3	5	7
0	13.26	13.22	13.07	19.74	19.64	19.50
50	7.42	7.41	7.39	13.50	13.40	13.27
75	5.96	5.96	5.95	11.20	11.12	11.06
100	5.00	5.00	5.00	10.00	10.00	10.00
300	5.00	5.00	5.00	10.00	10.00	10.00
350	4.65	4.66	4.63	8.69	8.69	8.70
400	4.14	4.15	4.17	7.67	7.68	7.68
450	3.73	3.73	3.76	6.85	6.86	6.86
600	2.88	2.89	2.91	5.14	5.15	5.15

Note: All the PACs have collars of 100% and 300% PSA, and were constructed off FNMA 3.5s (4.202 WAC, 349 WAM).

sizes, particularly in a flatter yield curve environment. Investors who can adapt to a longer paydown period by such means as modifying their cash management procedures, adopting more sophisticated techniques for modeling and managing their asset–liability positions, or initiating other procedural changes, would also be able to take advantage of the relative cheapness of wide windows.

Lockout

PAC bonds can be "locked out" in two ways. First, the entire PAC schedule can be locked out by adding a portion of the PAC schedule at the very front to the support classes; PAC bonds are locked out for the period over which those principal payments are made instead to support bonds. Typically, this lockout could extend from the first 12 to 24 months of the issue's life. The objective of the lockout is to stabilize the early support class. This is achieved by paying to the support bonds the principal cash flows that in effect have the highest effective collars (that is, they will be realized across a very wide range of prepays).

Table 13.4 contrasts the average-life variability of 3-, 6-, and 9-year PACs from a structure without any lockout with those from one with a two-year lockout. Both structures are backed by the same collateral, FNMA 3.5s (4.202 WAC, 349 WAM), use the maximum PAC schedule consistent with collars of 100% to 300% PSA, and, as appropriate, a

Table 13.4 Average-life variability of 3-year, 6-year, and 9-year PACs with and without lockout

	Average Life (Years)					
	No Lockout			2-Year Lockout		
Prepayment Speed (% PSA)	3-Yr	6-Yr	9-Yr	3-Yr	6-Yr	9-Yr
0	8.26	15.07	18.54	5.23	12.30	16.82
50	4.42	8.86	12.27	3.50	7.81	11.53
100	3.00	6.00	9.00	3.00	6.00	9.00
300	3.00	6.00	9.00	3.00	6.00	9.00
350	2.92	5.34	7.84	3.00	5.39	7.82
400	2.73	4.74	6.92	2.91	4.78	6.91
450	2.54	4.25	6.19	2.75	4.30	6.17
600	2.09	3.26	4.67	2.23	3.29	4.65

Note: Both PACs have collars of 100% and 300% PSA, and were constructed from FNMA 3.5s (4.202 WAC, 349 WAM).

lockout. (The 20-year bonds are not included in the comparison because their average lives were too different after matching the earlier bonds.)

In this example, the lockout benefits the PAC bonds by reducing both call and extension risk. Earlier bonds benefit more than later bonds, with the 9-year classes displaying only marginal reductions in average-life volatility. Two effects are at work here. First, the lockout reduces the size of the schedule by removing all payments in the first two years. This results automatically in a smaller amount of PAC bonds relative to the support bonds; conversely, more support bonds protect the remaining PAC schedule. Since they contain those cash flows from the collateral with the lowest degree of call risk, the support bonds are much less vulnerable to call risk, and even at very high prepayment speeds a larger proportion of support bonds remain outstanding to shelter the PAC bonds than would otherwise have been the case. At the same time, these principal amounts are no longer bound to a schedule, meaning that later scheduled payments have a better likelihood of being paid on schedule in the event of speeds below the bottom collar.

The second form of lockout is a natural form of call protection common to all types of CMO structures. It refers to the bonds (or principal amount of bonds) that will pay down, in the worst case, before the specific bond begins to pay principal. In a simple sequential structure, all but the shortest average-life bond enjoy some lockout while earlier bonds in the structure pay down. PACs enjoy explicit call protection from the support bonds as well as inherent call protection from any earlier bonds in the schedule. In other words, the longer the average life, the better the bond's inherent call protection. The impact of lockout is particularly apparent when we examine the effect of average life on option costs later in this chapter.

Effect of Z (Accrual) Bonds on PAC Performance

A Z, or accrual, bond ("Z" standing for zero coupon) is a type of CMO bond structure that pays no interest until it begins to pay principal. Until that time, the interest payments are accrued at the coupon rate and added to the principal amount outstanding. A Z bond is most typically included in a CMO structure as the last bond class to be retired. Of course, the underlying collateral continues to pay coupon interest; the portion that would have gone to the Z-bond holders, had it been structured as a coupon-paying bond, is used instead to retire the earlier classes. In effect, then, the presence of a Z bond permits CMO structurers to increase the size of the earlier classes, since the "accrual" amounts are additional to the projected principal payments from the collateral. More pertinently, the "accrual" helps to stabilize the earlier bonds, since a portion of the cash flow used to retire them is not directly determined by the level of prepayments.

The interaction of Z bonds with earlier classes is discussed in detail in Chapter 14. Readers who are unfamiliar with the Z-bond structure, or are interested in more complex manifestations of the Z structure, should refer to that chapter. The objective of this discussion is to examine the value, if any, that a long-term Z bond contributes to PACs. A related objective is to explore the possibility that accrual from the Z bond is used to stabilize earlier support bonds and not the PAC bonds, or equivalently, to pay down stated-maturity-type bonds. Such a mechanism might not be explicitly disclosed when the bonds from the structure are traded, and may only be indicated in the prospectus or by careful review of the entire issue.

Table 13.5 compares the average-life variability of two PAC structures. Both structures are backed by the same FNMA 3% collateral (3.753 WAC, 355 WAM), and have collars of 85% to 300% PSA. The schedule has been divided into a series of bonds with nominal average lives of one, two, three, five, seven, ten, and 20 years, the average lives of all but the 20-year matching to within two decimal places (as in the lockout example, because the schedules differ significantly in amount, the 20-year bonds are not comparable). The left PAC structure has a Z bond whose accrual is used to pay down both the PACs and the earlier support bonds. The right PAC structure also has a Z bond, but this Z's accrual is only used to pay down the earlier support bonds.

There is a noticeable difference in average-life performance between the PACs supported by a Z bond and the PACs whose support bonds alone are supported by the Z bond. The Z bond stabilizes the PAC bonds when prepayments break the lower collar. This makes sense—accrual cash flow is generated as long as the Z bond is outstanding. On the other hand, PAC bonds shorten more sharply in the structure with the Z bond when the upper collar is broken, because a smaller proportion of support bonds is outstanding at any time to cushion PACs from high rates of prepayments. In fact, the faster the prepayments, the smaller the principal balance of the Z bond when it begins to absorb excess cash, and the quicker it can be extinguished.

Table 13.5 Comparison of average-life variability of PAC strips structured with different pay rules for the Z bond

	Average Life (Years)											
	Accrual to PACs and Supports						Accrual to Supports Only					
Prepayment Speed (% PSA)	1-Yr	2-Yr	3-Yr	5-Yr	7-Yr	10-Yr	1-Yr	2-Yr	3-Yr	5-Yr	7-Yr	10-Yr
0	1.68	3.71	5.97	9.80	12.92	15.62	1.98	4.49	7.25	11.72	15.22	18.55
50	1.18	2.37	3.68	6.24	8.66	11.11	1.21	2.44	3.83	6.55	9.16	12.29
85	1.00	2.00	3.00	5.00	7.00	10.00	1.00	2.00	3.00	5.00	7.00	10.00
100	1.00	2.00	3.00	5.00	7.00	10.00	1.00	2.00	3.00	5.00	7.00	10.00
300	1.00	2.00	3.00	5.00	7.00	10.00	1.00	2.00	3.00	5.00	7.00	10.00
350	1.00	2.00	3.00	4.62	6.16	8.74	1.00	2.00	3.00	4.80	6.21	8.74
400	1.00	2.00	2.93	4.16	5.48	7.76	1.00	2.00	3.00	4.38	5.54	7.77
450	1.00	2.00	2.80	3.79	4.95	6.98	1.00	2.00	2.93	3.98	5.00	6.98
600	1.00	1.98	2.54	3.02	3.87	5.33	1.00	2.00	2.54	3.16	3.90	5.33

Note: The first pays accrual to the PACs and supports; the second pays accrual only to the supports.

This example should warn investors not to assume, however, that because a Z bond is present in the structure that the PACs will have less extension risk. There is no rule in the marketplace requiring issuers to pay accrual to PAC bonds. In some market environments, diverting accrual to the support bonds can make them more marketable, and a CMO arbitrage more viable. If this is the case, then issuers will structure their CMOs accordingly.

Readers also may have noticed that the average-life profile of the PACs that receive no accrual in this example is identical to that of the PACs backed by the same collateral in a structure with no Z bond. (See left half of Table 13.2.) In other words, for PAC buyers, diverting accrual to the support bonds is the same as not including a Z bond in the structure at all. This makes sense: the same aggregate amount of support bonds is available to support the PAC bonds, with the only difference being that the weight of support principal payments is shifted forward in time since the payments to the non-Z support bonds consist in part of interest accrued by the Z bond.

Effect of Jump-Z and VADM Structures on PAC Bonds

In 1990, structurers began to create a special bond class from the accrual thrown off by a Z bond. Known as VADMs (very accurately determined maturity) these bonds first appealed to savings and loan institutions, which are required by regulation to maintain a portion of their assets in very high-quality, short-term investments, and, accordingly, are willing to pay a premium for instruments that qualify and offer yields more attractive than those of, for example, government issues. These bonds also appeal to investors such as commercial banks, who are sensitive to the extension risk associated with rising yield environments. The size of a VADM class is determined by the amount of accrual (or accrual and principal) thrown off at a zero-prepayment rate up to the desired final maturity; obviously, faster prepayments will shorten the maturity, but no event can lengthen it. The presence of a VADM has the same effect on the PAC performance as diverting the accrual to the support classes has in the preceding example.

In a handful of issues, structurers designed the support Z bonds to convert to a "payer" early, changing their priority among support bonds for principal from last to current. There are a variety of ways to make a Z "jump"; the chief ones are described in Chapter 14. Once the Z bond converts to the current pay bond and begins to pay coupon interest, its support is no longer available to the PAC classes. The effect on PAC performance is generally the same as in the basic example above. However, the degree to which the PACs lose extension protection is moderated by the amount of time it takes to trigger the conversion, and by whether the jump is a temporary response to some condition (such as a specified prepayment threshold) or permanent (a "sticky" Z). This structuring strategy was more common in the late 1980s and is never seen in the current environment.

Priority to Receive Excess Cash Flows

The PAC schedule is protected by the existence of support classes. The mechanism is simple: in any period, the support bonds absorb all principal in excess of the scheduled payments, and any current-paying PACs have first claim on all principal received. This protection ceases when all the support classes have been fully retired, an event that occurs if the collateral consistently pays at speeds above the top collar. Once the support bonds are retired, any principal is distributed to the outstanding PACs, according to priorities defined for the particular CMO issue. Frequently, these priorities pay excess principal to the outstanding PACs in order of final maturity, but this is not always the case. A wholesale examination of CMO prospectuses will unearth numerous examples of structures that paid excess in the reverse of maturity order or otherwise insulated some classes at the expense of others. The impact of such schemes has, as would be expected, a significant effect on the average-life volatility of the various PACs.

For example, one perverse possibility would be to pay excess principal in the reverse maturity order. As one would expect, reversing the order in which PACs are subjected to prepayments above the top collar drastically alters the average-life performance of the PACs, if prepayments are outside the collars. Shorter PACs benefit at the expense of the longer. When the excess is paid in reverse, the short- and intermediate-term PACs are more significantly stable; when prepayments increase, longer PACs, with 10- and 20-year average lives, shorten up much more significantly.

The Option Costs of PAC Features

Most participants in the PAC market evaluate individual bonds by examining their average life and yield over various constant prepayment scenarios outside the collars, a technique similar to the one used in this chapter to analyze the various PAC features. The procedure has recognized disadvantages, some of which can be reduced to the complaint that they use a constant prepayment assumption. Using such tools, investors can devise investment criteria for PACs such as "I will buy 10-year PACs with four-year windows at a spread of 120 basis points to Treasuries if they don't shorten to less than eight years' average life given an instantaneous 200 basis point (bp) drop in yields." Implicitly, they are using these tools to measure and value the prepayment options embedded in their PAC bonds. However savvy and tough-minded the criteria sound, they are at bottom purely subjective guesses about how much the random exercise of those options will impair or help investment results.

A more systematic way to value PACs is via option-adjusted spread (OAS) analysis. By projecting expected prepayments across hundreds of possible interest rate scenarios over the life of the bond, this approach derives an average cost of the prepayment options in the PAC, and determines the expected reduction in total spread caused by interest rate volatility.[3] Furthermore, this approach enables calculation of option-adjusted spread, duration, and convexity.

Option-adjusted spreads (OASs) vary with market conditions. For this reason, a discussion of current OASs is inappropriate here. However, the option costs derived from the analysis are more stable, and can be discussed here without becoming hopelessly stale with the next rally or correction in fixed-income markets.

As expected, PACs demonstrate lower option costs than the underlying passthrough securities. Option costs in the current coupon-backed structures discussed in this chapter generally ranged from 0 to 35 bps for bonds with 3- to 20-year average lives. By comparison, the collateral (FNMA 3s) had 50 bps of option cost. (Bear in mind that absolute measures of option costs, yields, and so forth are calibrated to a specific option model. PAC and other CMO option-adjusted spreads and costs should always be benchmarked to those demonstrated by the collateral in the same model.) Because the weighted average of the option costs of all the bonds in the deal have to match the option cost of the collateral, the support bond ends up having a much higher option cost; for the PACs considered in this chapter, that option cost was 80 to 100 bps.

[3] The model employed in this discussion, like many other OAS models, used Monte Carlo simulation to generate 256 interest-rate paths and also used an econometric prepayment model.

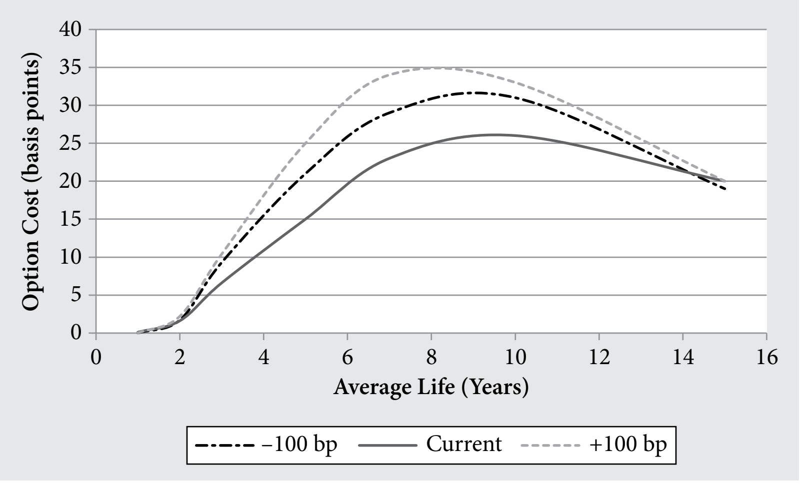

FIGURE 13.4 Option cost as a function of average life for a PAC strip (85% to 300% PSA collars)
Note: Constructed off FNMA 3s (3.753 WAC, 355 WAM)

Figure 13.4 illustrates a typical pattern for option cost as a function of nominal average life. This illustration corresponds to the PAC strip off FNMA 3% considered in the left half of Table 13.2. The option costs for this PAC strip are analyzed in three scenarios: assuming that the interest rate environment (of July 31, 2015) remains constant and assuming instantaneous parallel shifts in interest rates of up and down 100 bps.

As average life increases from zero to seven years, the option cost rises, and then it gradually declines for longer average lives. This behavior holds in the current interest rate environment, as well as in the cases of rates 100 bps higher and lower. There are two forces at work here. At first, as average life increases, the prepayment option has more time to go into the money, and so the bond option cost increases. On the other hand, the PACs having average lives longer than seven years are locked out for so long that they have limited ability to extend further, thus limiting extension risk and option cost. Furthermore, by the time the long PACs become current pay, the collateral is more likely to be burned out, thus further dampening option cost.

Though the shape of the option cost curves is basically the same for all three rate environments, the level of the curve is lowest in the current rate environment and is highest in the +100 bp rate environment. Compared to the current rate environment, lower rates increase the probability of prepayment speeds above the top collar, thus breaking the PAC and increasing option cost. Higher rates increase the probability of prepayment speeds below the bottom collar, again breaking the PAC and increasing option cost.

When the effect of a lockout was examined using average-life profiles (see Table 13.4), the benefits to the PACs were more pronounced the earlier the bond came in the series.

Table 13.6 Option costs of 3-year, 6-year, and 9-year PACs with and without lockout. Both PACs have collars of 100% and 300% PSA

	No Lockout			Lockout		
Average Life	−100 bp	Current	+100 bp	−100 bp	Current	+100 bp
3	21	21	28	13	17	18
6	29	37	47	41	38	45
9	49	44	52	51	46	55

Note: Constructed from FNMA 3.5s (4.202 WAC, 349 WAM)

By explicitly valuing the option costs for the same example, a similar effect is observed, as shown in Table 13.6. However, the 6- and 9-year tranches receive no benefit from the lockout on an option cost basis, whereas their average lives are observed to lengthen less sharply in extremely slow prepayment rate environments.

The impact of various window lengths on 5- and 10-year PACs was also examined, with no significant increase or diminution of option costs observed. This reiterates the conclusion, stated earlier in relation to Table 13.3, that the length of the window does not significantly affect the average-life stability of the bond outside the collars. Some security analysts and investors resist this result. They believe, for instance, that a tight window lowers the likelihood of breaking the collars during the paydown period. Therefore, they reason, the prepayment options that they effectively hold should be less costly. The time value of the options, however, includes the period prior to the first payment, because the protection implicit in the collars can be damaged or enhanced by prepayment experience in earlier months or years of the structure's life. More than one full interest rate and housing industry cycle can occur before a single principal payment is made to a 5- or 7-year PAC, with periods of slower prepayments tending to improve a PAC's call protection and faster prepayments tending to erode it. If prepayments violate the lower collar when earlier PACs are paying, both the call and extension protection of the later PACs can actually improve! When many such possibilities are simulated, the net effect should be small or negligible.[4]

Table 13.7 displays the option costs for two series of PACs in Z-bond structures, one funded by the Z bond and one not. The results reinforce the fact that the Z bond helps reduce the extension risk in the PACs but exposes them to additional call risk. The PACs paid down with accrual tend to have higher option costs, except in the bearish case, where prepayments are less likely to retire the Z bond before the PACs have been paid.

[4] The first PAC, then, should benefit the most from a tight window. A 2- or 3-year PAC, however, already tends to have a short window and very low option costs, for reasons previously explained.

Table 13.7 Comparison of option costs of PAC strips structured with different pay rules for the Z bond

	Z Funds PACs and Companions			Z Funds Companions Only		
Average Life	−100 bp	Current	+100 bp	−100 bp	Current	+100 bp
1	0	0	0	0	0	1
2	6	2	3	2	1	3
3	14	7	12	9	6	11
5	27	16	24	22	14	25
7	35	23	30	30	22	34
10	34	24	26	32	26	32

Note: The first pays accrual to the PACs and supports; the second pays accrual only to the supports.

Key Points

- The scheduled payments of PACs, protected over a wide range of possible prepayment speeds, appeal primarily to insurance companies and other buy-and-hold investors who are matching specific liabilities.
- The liquidity, yields, and wide diversity of features in the PAC market attract growing numbers of active bond managers.
- Misconceptions about the value of certain PAC features can create a number of opportunities for investors in both groups. Most notably, the length of the PAC window does not contribute to economic value; lockouts benefit short-term average-life PACs as well as companions; and Z bonds can protect earlier PAC bonds from extension risk.
- Investors who fail to stress-test PAC investments may overlook the fact that effective collars are significantly different from those stated at issue.
- Any kink or deviation from sequential order in the prioritization of excess cash flow to the PACs after support classes are retired must be detected, as it could drastically affect the performance of the longer-term PACs.
- Although the impact on value is less dramatic, investors should determine whether a long-term Z bond pays companions or PACs in the structure.
- PACs are normally evaluated by examining the yields and average lives of PAC investments over a variety of prepayment scenarios. Such analyses must be carried a step further and linked to possible interest rate scenarios.
- The soundest way to analyze PACs is to employ a prepayment model that explicitly recognizes the determinants of prepayment behavior. Such an analysis can be supplemented and its insights extended by employing option-based pricing methods.

CHAPTER 14

ACCRUAL BONDS/Z BONDS

LINDA LOWELL, GLENN SCHULTZ, AND FRANK J. FABOZZI

After reading this chapter you will understand:

- the dealer's motivation for including an accrual bond (more popularly referred to as a Z bond) in a CMO REMIC transaction;
- how the presence of a Z bond improves the REMIC arbitrage;
- the structuring rationale for including a Z bond and the mechanism by which a Z bond manages the average-life profile of its target classes;
- the cash flow profile of a Z bond and the investment objective which the Z bond is tailored to address;
- the major difference between a Z bond and the traditional zero-coupon bond;
- the structural difference between a Z bond, trick Z bond, and jump Z bond and their respective return profiles under various interest rate environments.

The accrual bond is a long-dated bond which is structured in such a way that it does not pay its coupon interest until it begins to pay principal. Rather, the principal balance accrues by the stated coupon amount on each payment date while the actual interest payments are redirected as principal payments to those bonds having a higher principal payment priority—the target bonds. Structurally speaking, the presence of an accrual bond serves two purposes: (1) to manage the average-life profile of the target bonds, and (2) to "clean up" tail cash flows.

Once the earlier classes in the structure have been retired, the accrual bond begins to amortize and pays both principal and interest as would any standard CMO bond. The accrual bond is commonly referred to as a Z bond since it is conceptually equivalent to a zero-coupon bond during its accrual phase. A bond created in this way provides the investor with a long duration, attractive yield, and protection from reinvestment risk throughout its accrual period. The cash flow pattern produced is suitable for matching long-term liabilities, and, as a result, the bonds are sought after by pension fund managers, life insurance companies, and other investors seeking to lengthen the duration of their portfolios and reduce reinvestment risk.

Z bonds have been a staple product of the CMO market since its earliest days. The bulk of the Z bonds currently outstanding are from traditional, sequential-pay CMOs, and have adapted well to the PAC-companion structure favored by the market since the late 1980s. The inclusion of an accrual bond in the last class continues to be a common practice. Recall, one objective of the Z bond is to "clean up" tail cash flow. Thus, when used in a PAC-companion structure, the presence of a Z bond derived from the companion bond serves to shorten the average life of the parent companion bond as well as truncate its tail cash flow. The structural flexibility of the Z bond made it a focus of innovation in the CMO market, as issuers created a significant amount of intermediate average-life Z bonds, a growing number of bonds of various average lives that accrue and pay according to a PAC schedule, and bonds that use various conditions or events to activate or deactivate the accrual mechanism. Together, these innovations expanded the traditional market for Z buyers by improving the stability of Z bonds' cash flows, issuing Z bonds in a wider range of average lives, or by creating bonds that perform well when interest rates increase or preserve their high yields when interest rates decline.

The chapter discusses this important sector of the CMO market. We begin with an examination of the mechanics of the traditional Z bond as well as Z bonds issued with PACs, and focus on the behavior of these structures under different prepayment scenarios. We also consider the effect of the presence of a Z bond on the other bonds in a CMO, and the relationship between the basic characteristics of the Z bond and its market properties and economic performance. A discussion then follows of the characteristics of more complex Z-bond structures, such as serial Z bonds, Z PACs, and Jump Zs.

The Basic Accrual Structure

Most Z bonds have been issued from traditional, sequential-pay CMO structures. Typically, they have been the last in a four-class bond issue, and had nominal average lives of 20 years. The principal and interest cash flows for a traditional, sequential-pay CMO containing a Z are diagrammed in Figure 14.1. As the graph indicates, the first class pays principal and interest until it is retired, at which time the second class begins to pay down. The coupon-paying bonds, Classes A, B, and C, receive payments of interest at their stated coupon rates on their original principal balances. The Z bond, however, receives no payments of interest until the preceding classes are fully retired. Instead, the Z bond's interest is paid to the target bonds (B and C) as principal while its principal balance accrues at the stated coupon rate, in effect guaranteeing the bondholder a reinvestment rate equal to the coupon rate during the accrual period, and insulating the investment from reinvestment risk as long as the earlier classes remain outstanding.

A review of the principal payment rules of the basic structure illustrates the redirection of the Z bond's interest as principal to the target bonds—in this case B and C.

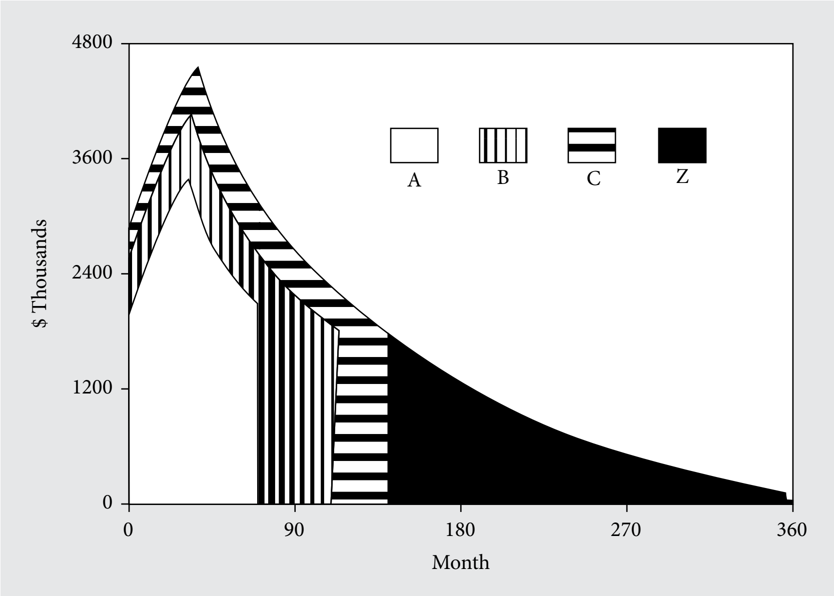

FIGURE 14.1 Total principal and interest payments of a traditional sequential-pay CMO with a Z bond
Note: Prepayments at 165% PSA

1. The Z accrual amount to B and C in that order, until retired, and thereafter to Z.
2. The collateral group cash flow distribution amount to A, B, C, and Z in that order, until retired.

The Z "accrual amount" is any interest then accrued and added to the principal balance of the Z class. The "collateral group cash flow distribution amount" is the principal then paid on the collateral group MBS.

A Z bond's principal balance outstanding can triple or quadruple over the accrual period projected at the time of issuance. This is graphically depicted in Figure 14.2, which indicates the growth of the principal balance of the Z bond structure presented in Figure 14.1 over its expected life at an assumed constant prepayment speed of 165% PSA. The principal balance of the tranche at issue is $25 million, and grows to a maximum level of $79.5 million by about the 150th month. From that point, coinciding with the last payment to the preceding tranche, the outstanding principal balance begins to decline as scheduled amortization and prepayments from the collateral are paid to the Z bond.

If actual prepayments occur at a faster rate than 165% PSA, the principal balance of the Z class at the end of the accrual period will be smaller than the $79.5 million shown in the diagram. Since the earlier tranches pay down sooner, the Z bond principal balance accrues over a shorter period of time, and the total amount of accrued interest is lower. Conversely, slower prepayments allow the Z bond to accrue for a longer period, resulting in a larger principal balance at the time when the Z bond begins to amortize and pay principal. The projected principal balances at the end of the accrual period are shown for various constant prepayment speeds in Table 14.1. At the pricing speed of 165% PSA, the

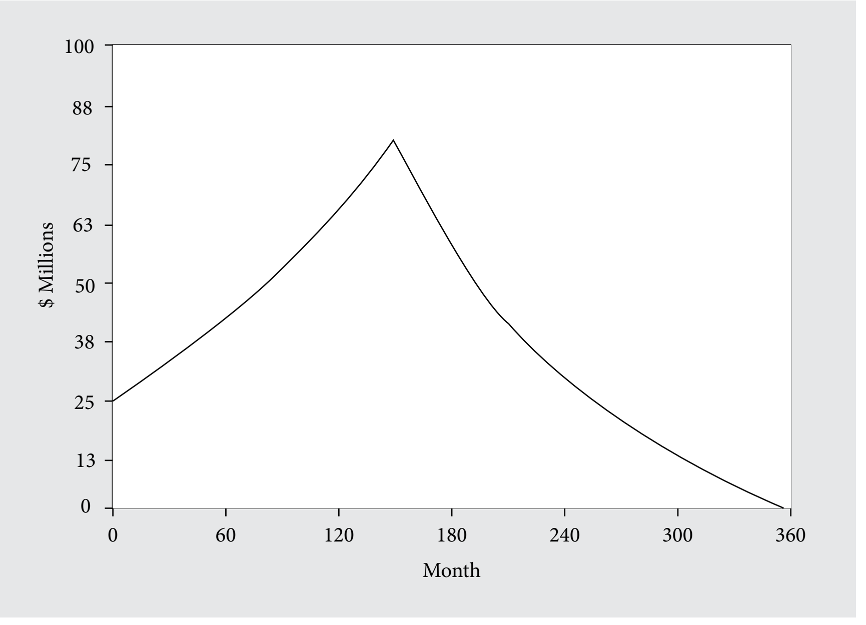

FIGURE 14.2 Principal balance of a Z bond over time—$25 million beginning balance
Note: Prepayments at 165% PSA

balance in this example reaches an amount more than three times the size of the original face amount at issue. At a faster speed of 350% PSA, the original face amount doubles, and at a slower speed, 100% PSA, it quadruples. Likewise, faster prepayments accelerate the receipt of the first payment of principal and interest. In the example, the first payment jumps from halfway into the 12th year at 165% PSA to the beginning of the 9th year at 350% PSA. If prepayments slow to a constant rate of 100% PSA, the first payment to the Z bond is not made until the beginning of the 16th year after issue.

The effect of faster or slower prepayments on the yield and average life of the same example is shown in Table 14.2, under the heading "Z Bond in a Traditional Sequential-Pay CMO." The average life of the Z bond at the pricing assumption of 165% PSA is about 18.5 years; traditional Zs typically have average lives at a pricing of 18 to 22 years (and expected accrual periods of eight to ten years). If prepayments occur at a constant rate of 100% PSA, the bond lengthens modestly, to an average life of about 22 years. Like other last tranches, the Z has more room to shorten. In this example, the Z shortens to an average life of about 12 years at 350% PSA, and down to about 7.5 years at 600% PSA.[1]

[1] Average-life calculations are intended to measure the weighted-average time until receipt of principal payments. Some measures of expected life may include the accrued interest as a cash flow. These increases in the principal balance can enter the calculation as negative weights applied to the elapsed time to early payment dates, and the actual principal payments as positive weights applied to the elapsed time to later payment dates. By placing negative weights on small numbers and positive weights on large numbers, the results can be larger than the remaining term of the underlying collateral

Table 14.1 Effect of prepayment speed on the length for the accrual period and the principal balance at the end of the accrual period of a $25 million 20-year average-life Z-bond class

Payment Speed (% PSA)	Principal Balance Outstanding ($MM)	Months from Issue
75	115.4	194
100	102.1	180
125	91.8	166
165	79.5	150
200	71.4	135
250	63.4	119
300	57.2	106
350	52.9	96
425	46.6	80
600	41.1	64

Note: Total issue $300 million sequential-pay CMO backed by FNMA $9^1/2$s

The yield received on a Z bond is less sensitive to differences in prepayment speeds the closer its price is to par ($100). At deeper discounts, Z bonds, like other discount mortgage-backed securities, will benefit in a higher than expected prepayment environment as their average lives shorten and principal is returned at par earlier than that assumed at pricing speed. The deeper the discount the sharper the boost in yield as prepayment speeds increase. Conversely, the yield declines as a function of a slowdown in prepayments and the original discount.

How the Z Interacts with Other Bonds in the Structure

The interaction of the Z bond with earlier bonds in the CMO structure is a key determinant both of its own behavior and that of the other bonds. By including an accrual bond in the CMO structure, issuers accomplish two purposes: (1) a higher proportion of the total issue can consist of tranches with earlier final maturities than if there were no Z bond in the structure, and (2) the earlier classes have more stable cash flows and

(for example, a number of years greater than 30). To avoid this unrealistic result, the convention in the CMO market is to exclude from the calculation all increases in the factor or balance, with the understanding that this method can substantially understate the true interest rate sensitivity of a security.

Table 14.2 Yield and average life at various prepayment speeds of comparable CMO and 20-year average-life bonds in structures with and without Z bonds (pricing assumption: 165% PSA)

	Coupon-Paying Bond in a Traditional Sequential-Pay CMO*		Z Bond in a Traditional Sequential-Pay CMO[a]		Z Bond in a PAC Structure[b]
Payment (% PSA)	Yield (%)	Average Life (Years)	Yield (%)	Average Life (Years)	Yield (%)
0	9.97	25.01	9.82	22.91	10.17
100	9.98	23.25	9.83	21.71	10.20
200	9.94	21.40	9.83	20.47	10.24
500	10.00	18.55	9.85	18.55	10.30
700	10.02	16.41	9.86	17.02	10.35
900	10.05	13.88	9.89	15.02	10.44
300	10.08	11.92	9.91	13.37	10.52
350	10.11	10.38	9.93	11.96	10.69
425	10.15	8.66	9.98	9.80	11.18
600	10.27	6.18	10.06	7.61	13.02

Notes: * Price: 96:28; [a] Price: 96:29; [b] Price: 90:10

average lives across a range of prepayment rates than in a comparable structure without a Z bond. Furthermore, since the timing of cash flows from the Z bond depends on the retirement of the earlier tranches, the Z bond is also more stable.

An accrual bond supports a larger proportion of early classes because the coupon interest that would have otherwise been paid on the outstanding balance of the Z bond is added to the principal payments from the underlying collateral and used to retire the principal balance outstanding of the earlier classes. At the same time, the principal amount of the Z bond is increased by the dollar amount of interest paid as principal to the target classes. Simply stated, during the accrual period the Z bond's interest is capitalized as principal. At first blush, this may appear a sleight of hand trick, which is not the case because the accrual procedure maintains a simple algebraic relationship in which the sum of the principal balances of the outstanding bonds is always equal to that of the outstanding principal balance of the collateral. The numerical example in Table 14.3 illustrates this relationship. In the example, the collateral pays a 10% coupon and a $100 principal balance in ten equal payments. Both Class A and Class Z have stated coupons of 10%, so that the sum of the interest paid to Class A and either accrued or paid to Class Z is always equal to the interest paid by the collateral. Notice that Class A is paid down more quickly than it would be if the Z were a coupon-paying bond.

The accrual structure permits issuers to create larger classes with short- and intermediate-term average lives. The effect of an accrual bond on the size of the earlier classes is

Table 14.3 How a Z bond accrues and pays: A simplified example

Collateral: $100 10% loan amortizing in 10 annual payments

CMO: Class A $50 paying 10% coupon; Class Z $50 Z with 10% coupon

	Collateral			Class A			Class Z		
	Payments			Payments			Payments		
Payment	Interest ($)	Principal ($)	Balance ($)	Interest ($)	Principal ($)	Balance ($)	Interest ($)	Principal* ($)	Balance ($)
0	0.00	0.00	100.00	0.00	0.00	50.00	0.00	0.00	50.00
1	10.00	10.00	90.00	5.00	15.00	35.00	0.00	(5.00)	55.00
2	9.00	10.00	80.00	3.50	15.50	19.50	0.00	(5.50)	60.00
3	8.00	10.00	70.00	1.95	16.05	3.45	0.00	(6.05)	66.55
4	7.00	10.00	60.00	0.34	3.45	0.00	6.66	6.65[a]	60.05[b]
5	6.00	10.00	50.00	0.00			6.00	10.00	50.00
6	5.00	10.00	40.00	0.00			5.00	10.00	40.00
7	4.00	10.00	30.00	0.00			4.00	10.00	30.00
8	3.00	10.00	20.00	0.00			3.00	10.00	20.00
9	2.00	10.00	10.00	0.00			2.00	10.00	10.00
10	1.00	10.00	10.00	0.00			1.00	10.00	0.00

Note: * Amounts in parentheses are not cash flows but upward adjustments of principal balance.
[a] $6.65 = Principal remaining after Class A retired.
[b] $60 = Previous balance - Principal Paid = $66.55 – $6.65.

graphically illustrated in Figure 14.3, a diagram of the principal payments only from the CMO in Figure 14.1. The discontinuity between the size of principal payments to the Z and those to the earlier tranches reflects the fact that the Z bond's pro rata share of coupon interest is treated as principal in order to pay down the earlier tranches. The strategy of including a Z bond in a structure is attractive to issuers when the CMO arbitrage depends primarily on exploiting the steepness of the yield curve. By pricing a greater share of the transaction's cash flow to the short end of a steep yield curve the dealer is able to improve the CMO arbitrage. In periods when the yield curve is flat or inverted, this strategy helps issuers minimize the proportion of longer average life bonds in the issue. This works because interest payments from the collateral, which would have been paid to holders of the last tranche, are used to support the first tranche.

Table 14.4 highlights the effect of the presence of an accrual class on the allocation of principal to the earlier classes of a transaction. The table compares two four-tranche sequential-pay CMOs backed by the same collateral, one with a Z and one without. The four tranches in each issue have the same average lives, roughly three, seven, ten, and 20 years. (The fourth tranches from these examples, all nominally 20-year bonds, are included as well in Table 14.2.) The two structures differ in the way the collateral's principal is distributed among the classes. For example, in the Z-bond structure, a $25 million

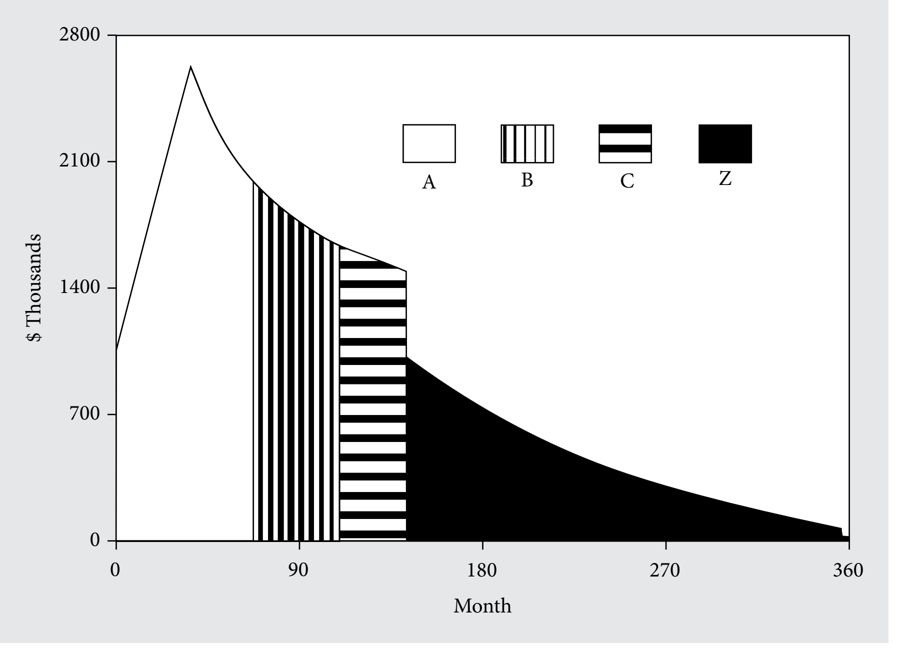

FIGURE 14.3 Total principal payments of a traditional sequential-pay CMO with a Z bond
Note: Prepayments at 165% PSA

Z-bond class supports a $136 million 3-year first tranche. The structure without a Z bond has $120 million 3-year bonds in the first class and $79 million 20-year bonds in the fourth tranche.

The accrual mechanism imparts greater stability to all the bonds in a typical structure. This is readily apparent in Table 14.5. Each column compares the average life at different prepayment speeds of the different tranches from the sample structures. In each case, the average lives of the tranches are less variable across all scenarios for the structure containing a Z bond than in the structure without.

CMOs with PACs and a Z Bond

The Z bond has a similar effect on earlier bonds in a typical PAC structure. For a given collateral and pricing assumption, accrual from the Z can be used to support a larger amount of PAC and companion bonds in the earlier tranches. The principal and interest payments for a structure containing 3- and 7-year PACs, a 7-year companion, and a 20-year Z are shown in Figure 14.4. The yield and average life at various prepayment levels of the Z bond from this structure are included in Table 14.2, and the size and average life of the various classes are shown in Table 14.5. (In fact, the average life of the Z bond is

Table 14.4 Comparison of various CMO structures created with and without Z bonds

	Traditional CMO Without Z		Traditional CMO With Z		PAC CMO with Z	
Class	Original Balance	Average Life	Original Balance	Average Life	Original Balance	Average Life
A	$120,000,000	3.0	$136,000,000	3.0	$80,000,000	2.8
B	66,200,000	7.4	84,000,000	7.4	70,000,000	7.0
C	34,500,000	10.9	55,000,000	10.9	125,000,000	7.3
D	79,300,000	18.6				
Z			25,000,000	18.6	25,000,000	18.6
Total	$300,000,000		$300,000,000		$300,000,000	

Note: Structured at 165% PSA

Table 14.5 Effect of a Z bond on the average-life variability of the various classes in a traditional sequential-pay CMO

	Average Life in Years							
	3-Year Tranche		7-Year Tranche		10-Year Tranche		20-Year Tranche	
Prepayment Speed	No Z Bond	With Z Bond	No Z Bond	With Z Bond	No Z Bond	With Z Bond	Coupon Bond	Z Bond
75% PSA	5.2	4.7	13.2	11.1	18.4	14.9	25.0	22.9
165% PSA	3.0	3.0	7.4	7.4	10.9	10.9	18.6	18.6
425% PSA	1.6	1.7	3.4	3.8	4.8	5.9	8.7	10.3

Note: Collateral: FNMA 9.5s

18.6 years, matching, for the sake of discussion, the average lives of the Z and regular coupon-paying tranches in the other examples.) Funding the earlier classes from the Z bond's accrual generally creates a much larger portion of available principal, for a given pricing speed, from which to carve PACs, allowing issuers to increase the size of the PAC classes.

Since companion bonds absorb the prepayment volatility from which the PACs are shielded, the proportion of PACs to companions is an important parameter in determining the degree to which the average lives of the companions will change over various prepayment scenarios. The presence of a Z bond increases the total amount of principal available at the pricing speed to pay both the PACs and the companions. This means that, all other factors being equal, more PACs may be issued with less negative effect on the stability of the companion bonds. In turn, the length of the accrual period is more stable. Nonetheless, given that the companion Z bonds created to support PAC tranches are derived from a parent companion bond, they are more volatile than those

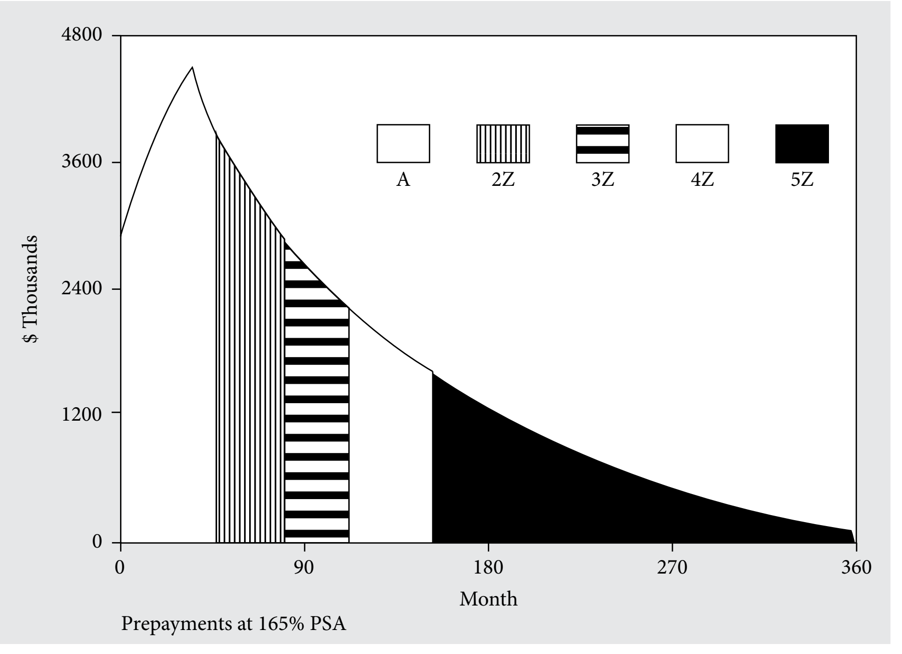

FIGURE 14.4 Total principal and interest payments of a CMO with PACs and a Z bond
Note: Prepayments at 165% PSA

Z bonds found in a sequential Z bond structure. The truth of this can be seen by comparing the average life at various prepayment speeds of a Z from a PAC structure to those of a Z from a traditional CMO, as was shown in Table 14.2. As is the case with the fourth tranches in the sample traditional deals, this Z also has an average life of 18.6 years at 165% PSA. As the table indicates, the average life of the Z from a PAC structure would extend more significantly as well, since slow prepayment rates will delay the retirement of the companion bonds, further extending the accrual period for the Zs. (This effect is obscured by oversimplification of the example.) If the companion tranche(s) in front of a Z are TACs, the Z may be more volatile than if structured with standard companions. When the priorities enforcing the structure require that principal in excess of the TAC (and PAC) payments be paid to the Z, then the Z may begin to receive payments before the companion TAC is retired. This kind of structure produces a Z that is much more volatile in bull markets than a traditional or companion Z bond. Prepayment speeds fast enough to shorten a traditional 20-year Z to a 10-year can shorten this bond to a 1-year. When they carry a low coupon, these bonds are priced to produce generous returns from accelerating prepayments. Indeed, this is one way to create the bullish Z bond known as a “Jump Z.” The Jump Z is discussed in greater detail later in this chapter.

Performance of Z Bonds

The variability in the yield of a Z bond over a range of prepayment rates gives at best an imperfect indication of the Z's expected price, and hence, economic performance in different interest rate scenarios. A major drawback of using yield as a measure of a Z bond's or, for that matter, any mortgage-backed security's expected performance is that the calculation of yield-to-maturity presumes that the amount and timing of cash flows are known with certainty and are reinvested over the life of the investment at a rate equal to the yield. In reality, mortgage-backed securities are more exposed to reinvestment risk than other common fixed-income investments. Most CMOs pay both principal and interest monthly. More importantly, prepayments of principal normally accelerate when market rates decline, just as the yields available on reinvestment opportunities are declining. The opposite occurs as market yields rise; prepayments decline, slowing the receipt of principal just as more attractive reinvestment opportunities appear. Z bonds are protected somewhat from this later source of reinvestment risk, since the reinvestment rate is locked in over the accrual period. Ultimately, the accrual period is of uncertain length, and when it ends the Z bond begins to pay exactly like a coupon-paying CMO bond—subjecting the investor to reinvestment rate risk. For these reasons, yield does not capture the difference in the Z bond's performance relative to a security with lower reinvestment risk, such as a Treasury bond that pays only coupons until maturity, or one with a fixed accrual period, such as a Treasury zero.

Prepayment risk also exposes investors to call and extension risk, and these have additional consequences for market value. For mortgage-backed securities purchased at prices above par, the early return of principal at par is a negative event, since less interest is earned over the investment horizon. Reflecting the market's perception of these risks, the prices of premium coupon CMOs, including Z bonds, rise more slowly the steeper the decline in interest rates. Investors also are exposed to possible declines in market value when a bond's average life extends and shifts outward across a positively sloped yield curve. When the average life of an MBS lengthens in an upwardly sloping yield curve environment, the discount rate applied to the expected cash flow rises, resulting in a lower market value.

Another characteristic that yield calculations cannot reflect is the call provisions established for CMOs. These tend to be more important in the case of older, non-REMIC CMOs issued before 1987 which used call provisions to insulate the transaction from a more onerous sales tax treatment. These CMOs had significant call provisions; some as high as 20%. Of these, few if any remain outstanding. Current practice in the agency REMIC market, is to strike the clean-up call provision at 1% of the current unpaid balance of all classes outstanding relative to the original unpaid principal balance.

Z bonds have considerably longer expected durations than coupon payers with similar average lives because the principal balance grows over time. Thus, the investor should expect Z bonds, on a total return basis, to underperform CMO payers and Treasuries with comparable average lives and maturities in bearish scenarios. However, as a result of the accrual mechanism, Z bonds tend to outperform comparable Treasury zeroes in rising rate scenarios. In bullish scenarios, the long duration of the Z bond produces high rates of return. However, under sharply declining interest rate scenarios the Z bond loses its advantage over comparable securities due to its callable nature which results in a shorter average life.

More Fun with Accrual Bonds

Over time, dealers have become more creative in their use of the basic accrual mechanism. The variations on the accrual theme include Z PACs and structures containing an intermediate- as well as long-term Z bond or a series of Z bonds of various average lives. Other structures turn the accrual mechanism on and off, depending on the amount of excess principal available after scheduled payments are met. As complex and exotic as these structures may appear at first glance, the same basic principles at work in traditional Z bonds continue to apply. And in most cases, any additional complexity is accompanied by considerable additional value for investors with particular objectives and investment criteria.

Z PACs

Z PACs combine the cash flow characteristics of a standard Z bond with the greater cash flow certainty of a PAC. When prepayments occur within the range defined by the PAC collars, the Z PAC will accrue to a scheduled principal balance over a fixed period and make scheduled payments thereafter. As with more familiar, coupon-paying PACs, any excess cash flow is absorbed by companions as long as they are outstanding. Similarly, the coupon interest earned on the Z-PAC's outstanding balance during the accrual period is used to support earlier classes in the structure, and the balance of the Z PAC is increased by an equal amount. For prepayment levels within the PAC collars, the structure eliminates reinvestment risk over a defined accrual period, and then provides predictable payments until maturity. This structure is particularly well suited to matching liabilities. The fact that Z PACs are issued in a range of average lives (typically five, seven, ten, or 20 years) increases their applicability. Furthermore, the call and extension protection provided by the planned payment schedule means that the duration of the investment is less likely to increase as interest rates rise (or decrease as interest rates decline) than is the duration of a standard or companion Z. That is to say, the Z PACs are less negatively convex than standard or companion Zs. For this reason, active portfolio managers should consider using the Z PAC to lengthen the duration of their portfolios in anticipation of market upswings.

Structures with More Than One Z Bond

Considerable variety is possible when structuring deals with multiple classes of Z bonds. Two common strategies are to issue a sequential series of Zs with a range of average lives (five, seven, ten, and 20 years, or seven, ten, 15, and 20 years, for example), or a pair of Z bonds having intermediate- and long-term average lives (5- and 20-year bonds or 10- and 20-year bonds are common examples). In the case of an intermediate- and long-term average-life pair, the bonds do not necessarily pay in sequence, but more typically pay down before and after intervening coupon-paying classes. Both strategies have been employed in traditional CMOs as well as in structures containing PAC bonds.

In general, multiple accrual classes in a CMO interact with the rest of the structure in the same way a single traditional Z bond does, supporting the repayment of earlier classes, which themselves may either pay coupon interest or accrue. In a series of Zs, the longer Zs lend stability to the shorter Zs, just as they would to coupon-paying bonds with earlier final maturities. Accrual from the later Zs can be used to retire earlier Zs when they become current-paying bonds, just as if they were coupon-paying bonds.

The cash flows from a sequential-pay CMO containing a series of 5-, 7-, 10-, and 20-year Zs preceded by a 2-year coupon-paying tranche are shown in Figure 14.4. This example was constructed using the same collateral and pricing speed as in the previous examples containing a single Z. The last tranche, 5Z, is the same size as in the previous example as well, and for this reason has the same average life at various prepayment speeds. For the sake of discussion, the first tranche is also the same size as the first tranche in the traditional CMO with a Z bond, $136 million. As indicated in Table 14.6, the large amount of accrual bonds in the structure has the effect of shortening the average life of this bond from three years at 165% PSA in the single Z example to two years. (Readers will note that this example is not necessarily realistic. A person structuring a transaction would prefer to issue larger amounts of short-term average-life bonds that can be sold at lower yields for greater arbitrage profits by manipulating the coupon and offer price, and so forth.)

Table 14.6 lists the average lives of the first five classes at various prepayment speeds. In general, intermediate-term Zs demonstrate considerable stability. This is more evident when the 7- and 10-year Zs are compared to the 7- and 10-year coupon-paying bonds from earlier examples in Table 14.6. The 10-year is supported by a 20-year Z, and is noticeably less variable than one in a CMO without a Z. As would be expected, given the larger amount of accrual being passed to successively shorter bonds in the current example, the 5-year Z bond is considerably more stable than a comparable 5-year standard payer supported by a single Z. The general result is that the shorter Zs in a series of Zs are "cleaner," that is, they have progressively less average-life variability than otherwise comparable coupon-paying bonds. Intermediate-term average-life Zs interspersed among coupon-paying classes in a structure supported by a 20-year Z (the other common strategy) will benefit similarly. They will be more stable than would otherwise be the case, and the degree of stability will depend on the size of the supporting Z.

Table 14.6 Average lives at various prepayment speeds of the bonds in a sequential-pay CMO with a series of Z bonds

	Average Life (years)				
	A	2Z	3Z	4Z	5Z
75% PSA	2.5	6.6	10.1	14.0	22.9
165% PSA	2.0	5.0	7.6	10.5	18.6
425% PSA	1.4	3.1	4.5	6.0	10.3

The consequences of multiple Z strategies are that they produce bonds possessing relatively stable cash flow patterns—not as stable as PACs with decent collars, but more stable than traditional sequential-pay bonds. These bonds also possess the partial shield against reinvestment risk that is a chief attraction of traditional Z bonds, and they make it available in any array of expected lives, broadening the appeal of Z bonds to investors with intermediate- rather than long-term horizons.

Tricky Zs

Other innovative approaches to Z bonds evolved over time with a common theme of turning the accrual mechanism on or off under certain conditions—hence their nickname "trick" Zs. One such condition might be a date; for example, the rule of allocating cash flows between classes might be "accrue until such and such a date" instead of the traditional "accrue until A, B, and C tranches are retired." Or, the decision to accrue the Z bond might depend on the amount of principal available to make payments to the non-accrual bonds currently paying. The use of these rules results in a Z bond with performance characteristics that can be very different than that of the "plain vanilla" Z bond previously discussed.

CMO issuers have tinkered with the accrual mechanism of Z bonds to create CMO classes that alternate between paying interest and accruing interest. These special-purpose classes are structured with a set of rules that turn their accrual mechanism on or off according to certain cash flow conditions. These accrual rules are often designed to help preceding classes meet their cash flow schedules and/or expected maturity dates. Dealers include variable-accrual bonds in CMO structures to help earlier classes meet the 5-year maturity requirement for inclusion in thrift liquidity portfolios. These "benevolent" Zs pay as follows: when cash flows from the mortgage collateral are insufficiently large enough to retire the liquidity bonds according to schedule, their accrual mechanisms are turned on and corresponding coupon from the collateral is applied to the earlier classes; when cash flows are sufficient to retire the liquidity bonds on schedule, their accrual mechanisms are turned off and the bonds act like standard coupon payers. Incorporating a conditional accrual rule into a bond class is an effective way to reduce extension risk on earlier classes. Of course, the extension risk is not eliminated. Rather, extension risk is transferred to the benevolent Z and other, later cash flow bond classes.

Another wrinkle is to permanently transform Z bonds into coupon-paying bonds when certain cash flow levels are met. An early example of this Z-bond structure was issued as the last of nine classes in FNMA 89-15. This bond was not marketed with any distinguishing label. The other bonds in the structure were a series of PACs and TACs followed by a companion dubbed an "S" bond. The Z bond pays as follows: any excess above the scheduled PAC and TAC payments is distributed to the Z bond as an interest payment; if the amount is lower than the amount that was accrued, the shortfall is accrued; if the amount is greater, the excess is distributed as principal; beginning in the month following the first payment of a complete interest payment, the so-called Z class distributes interest each month. One month of exceptional prepayment experience can trigger the conversion to coupon bond. Thereafter, the average life will be shorter than it would otherwise have been, owing to the fact that a portion of its cash flows is dispersed over what would have been the accrual period. Any protection against reinvestment risk offered by this "chameleon" bond is ephemeral at best. Once converted, the bond behaves like any other companion bond.

Even Z PACs have been subjected to genetic alteration. The first Z PAC issued, the fifth tranche in Ryland Acceptance Corporation Four, Series 88, accrues only until the date of its first scheduled payment or until non-PAC classes in the deal have been retired. Until that date, the Z PAC is the first PAC in line for excess cash flows should the companions be paid down, and after that date, it is last in line. This means it has greater call risk during the accrual period. As a result, its average life is only stable at or below the pricing speed (90% PSA for this deal backed by GNMA 8s). The resultant average-life volatility is more typical of a reverse TAC, which does not extend but has considerable call risk.

Jump Zs

Another Z-bond innovation, the jump Z, made its debut in the CMO market during the summer of 1989. Generically, the jump Z is a bullish companion Z bond that is designed to convert to a current payer and to receive excess principal when prepayments accelerate. Under bullish scenarios, this bond "jumps" ahead of other bond classes in the order of priority for receiving principal payments. Once triggered, a jump Z typically receives all excess principal (above scheduled PAC payments) until it is retired. Conceivably, holders of the jump Z could receive these payments early in the expected accrual period. This acceleration of principal can shorten the bond's average life significantly: a Z bond issued with a 20-year average life might shorten to less than one year. In general, a jump Z priced at a deeper discount will likely trade to a tighter spread, because investors assigned more value to the jump feature. Investors often purchased jump Zs as a means to offset the negative convexity of their other mortgage securities and to enhance the performance of their MBS portfolios in bullish scenarios. Although popular for a time, few jump Z bonds are issued today simply because the inverse floater became a more popular vehicle for bullish investors.

Jump Z bonds have been issued with an extremely diverse set of jump rules. Although apparently lacking uniformity or standardization, these rules have the common objective of increasing the bonds' performance in bullish economic environments. Jumps can be activated by an event associated with a market rally: rising prepayment rates, declining interest rates, or increased cash flow. However, most jump Zs were structured with prepayment triggers: the bonds shortened when prepayment rates on the underlying mortgage collateral rose above a CMO's pricing speed or some other predefined prepayment level. Generally, prepayments above the pricing speed shortened the average life of the jump Z considerably. In structures containing TAC bonds, jump Zs were often designed to shorten when prepayments exceed the speed that defines the TAC schedule. In addition to prepayment triggers, CMO issuers also structured jump Zs with interest rate triggers that were activated when Treasury yields fall below some threshold level. Interest rate triggers eliminated the need for investors to accurately forecast prepayment rates, and ensured that jump Z holders would benefit even in a market rally that was not accompanied by rising prepayments. In general, the closer the jump trigger is to actual prepayment speeds or current interest rates, the more valuable the jump Z.

Jump Z bonds can be classified as cumulative or noncumulative, as well as "sticky" or "non-sticky." A cumulative trigger is activated when since-issuance prepayment rates, or other cumulative measures of prepayment experience, exceed some threshold value. In contrast, a noncumulative trigger only requires prepayments to satisfy the jump condition during a single period. Holders generally prefer noncumulative triggers, since a single month of abnormally high prepayments could force early retirement of their discount security. The adjectives stick and non-stick indicate whether a jump Z bond will revert back to its original priority in the CMO structure if jump conditions are no longer met. Once triggered, a sticky Z will continue to receive principal payments, even if prepayments subsequently decline below the threshold value. On the other hand, a non-stick Z can revert back to an accrual bond once its jump rules are no longer satisfied. Holders generally assign the greatest value to jump Zs with noncumulative sticky triggers, because a single increase in monthly prepayment rates could force early retirement of the entire bond class. For jump Zs backed by unseasoned mortgage collateral, a tiny increase in prepayments could trigger a jump: a small increase in CPR can translate into a large PSA spike when prepayments are benchmarked off the early part of the PSA ramp.

The other common approach for creating a jump Z bond—preceding it with a TAC and other companion bonds in a PAC structure—was described earlier. The jump Z acts like a traditional companion bond and absorbs volatility from both PACs and TACs. Preceded by a TAC, the jump Z receives principal when principal payments from the underlying collateral and Z accrual exceed the amount required to meet the PAC and TAC schedules. The degree to which the bond's average life will shorten depends on its jump rules and the overall deal structure. Jump rules control whether the bond jumps in front of the TAC class when payments break the TAC schedule (sticky Z) or receives only excess payments above the PAC and TAC schedules (non-sticky Z). All else being equal, the average life of a sticky Z is likely to shorten more than a comparable non-sticky Z. Preceded by PACs, TACs, and other support bonds, these jump Zs have a negligible amount of extension risk since they are typically structured as the last companion class in the CMO. In addition to their jump rules, the average-life variability of jump Zs is also affected by the features of their preceding PAC bonds. For example, PAC lockouts, typically one to two years in length, can accentuate the shortening of jump Z average lives. Since no scheduled principal payments are made during a lockout, there is a much larger amount of cash flow available to pay down a jump Z in the event it is triggered. This simple form of jump Z (simple to visualize and analyze) does not involve any modification of the standard accrual mechanism: the Z's share of interest is added to principal payments used to pay down earlier bonds according to the schedules and order of priorities established for the deal. Some early jump Zs, however, had modified accrual mechanisms that imposed conditions under which accrual would be turned on or off. These rules can control how coupon interest is paid both before and after the bonds have jumped. Perhaps the most common example of accrual manipulation occurs with jump Zs that pay only a portion of their coupon interest and accrue the shortfall. The exact amount of interest that a jump Z will pay, after being triggered, often depends on the number and size of the companion classes that the bond jumped over. For example, when preceded by both Level I and II PACs, the amount of coupon interest paid to a jump Z bond will depend on whether it jumps over the secondary PACs. If the jump Z remains subordinate to the Level II PACs, then part of the jump Z's coupon interest can be used to support the second-tier PACs.

Z bonds offer investors some of the longest durations and highest yields available in the MBS derivative market, as well as a cash flow profile that is well suited to matching long-dated liabilities. In addition, Z bonds are one of the more liquid structures traded in the secondary market. So long as the yield curve is reasonably upward sloping, the economics of issuing Z bonds remains favorable and should ensure that sufficient supply of bonds are issued to meet investor demand for the structure.

Key Points

- Accrual bonds, also referred to as Z bonds, offer investors some of the longest durations and highest yields available in the derivative MBS market, as well as a cash flow pattern well suited to matching long-term liabilities.
- From a structural perspective, the purpose of the Z bond is to manage the average life and cash flow profile of the target bonds.
- Z bonds are one of the most liquid varieties of CMO bonds traded in the secondary market.
- Innovations have introduced accrual bonds with valuable characteristics, including greater stability or accelerated return of principal in rallies, and have widened the availability of intermediate-term Zs.

CHAPTER 15

SUPPORT BONDS WITH SCHEDULES

GLENN SCHULTZ, LINDA LOWELL, AND FRANK J. FABOZZI

After reading this chapter you will understand:

- how support bonds with schedules are created from the cash flows of support bonds in a structure;
- the types of support bonds with schedules and their relative cash flow performance;
- the influence of scheduled support bonds in a transaction on the remaining unscheduled support bonds;
- how time tranching is used to create a reverse TAC structure;
- the interest rate view (bearish or bullish) of each type of scheduled support bond.

As explained in Chapter 12, collateralized mortgage obligations (CMOs) were first devised to meet the following general objectives: (1) to achieve an efficient match between a wide range of investors' maturity requirements and the expected cash flows from a pool of mortgages and (2) to redistribute prepayment risk to different classes, thereby expanding the investor base.

The initial solution to the problem simply split the returning principal among a series of sequential-pay bonds—the sequential bond structure. Subsequently, this structure evolved into an array of reduced-risk CMO bond structures, the most heavily issued of which is the planned amortization class (PAC) structure. The PAC structure provides investors with scheduled principal payments occurring within a defined paydown period (window), and protected over a range of likely prepayment scenarios.

Support bonds (also referred to as companion bonds) are the natural byproduct of creating PAC bonds.[1] In order to protect the schedules of PAC bonds in a CMO

[1] As explained in Chapter 13, other structural devices intended to reduce or transform prepayment risk for some classes in a CMO issue also create support bond classes. The discussion here should not

structure, a sufficient amount of bond classes must be created to absorb excess principal paydowns and to provide a buffer from which scheduled payments can be made when prepayments are slow. Because support classes accept additional prepayment volatility, their principal payments are necessarily more uncertain than those of either PACs or sequential bonds. As a result, the actual yield or economic return realized from an investment in a support bond can vary widely from those projected at the time of investment. In recognition the incremental prepayment risk support bonds offer higher yields than either those of PAC or sequential bonds.

Issuers and underwriters have also developed a variety of devices that serve either to reduce the risk of a portion of the support classes or to create more volatile instruments that reward holders when interest rates (and presumably prepayment rates) move strongly in a particular direction. Lockouts[2] are among the first group, while super-POs and jump Zs are typical of the second. Another very common strategy is to create support bonds with floating and inverse floating-rate coupons. One of the oldest and most extensively employed strategies is to further define schedules to a portion of the cash flow of the support bond—further tranching the support cash flow. Naturally, the prepayment risk of a scheduled companion bond is limited relative to that of the primary PAC series. This family of reduced-risk support bonds is the subject of this chapter.

Support bonds having schedules partake either of the properties of targeted amortization classes (TACs)—so that they are protected against either call or extension risk (a reverse TAC) but not both[3]—or of PAC bonds, so that they have call and extension protection over a range of prepayment scenarios (a Level II PAC).

Support TACs first appeared in 1988, followed quickly by the issuance of reverse TACs. Level II PAC issuance first appeared in the third quarter of 1989. The 1990–4 interest rally (arguably the beginning of the secular interest rate bull market) witnessed the advent of the issuance of several levels of PACs each with successively narrower collars of prepayment protection, such that a single transaction would contain PAC Is, IIs, and IIIs. In addition, the practice of carving a "super-PAC" schedule out of a primary PAC schedule became popular.

The following discussion explains how support PAC and TAC bonds are created and how their structures affect each bond's performance under different prepayment scenarios. Further, the effect of adding a TAC, reverse TAC, or Level II PAC on the behavior of the remaining support bonds is also explored.

be presumed to apply to them. Unless clearly indicated, the term "support" when used in this chapter means PAC support.

[2] A lockout shifts to support bond principal payments that otherwise might be used in a PAC schedule as explained in Chapter 13. The effect of a lockout is to push forward the beginning of the first PAC window to a specified date and to stabilize the support bond. Lockouts are normally applied to the first PAC for a period of two or three years, lending stability to the earliest support bond class.

[3] See Chapter 13.

Support Bond Class Basics

Support bond classes are created from the principal payments remaining after the PAC schedules are defined. In general, the following principles apply:

1. Support bond classes have second claim on excess principal paid down from the collateral after the PAC schedules, and pay sequentially until all the supports are retired.
2. At the pricing prepayment assumption, support bond classes pay simultaneously with the PACs.
3. At slower constant prepayment rates, support bond principal payments are deferred until the PACs have been retired.
4. At higher constant prepayment rates, support bond principal prepayments are made simultaneously with the short-term average-life PACs and they are quickly retired, after which the PACs themselves must absorb excess paydowns and are retired ahead of schedule.

A simplified example of a standard PAC–support bond structure is depicted in Figure 15.1. The large unshaded area paying from the first to about the 300th month contains all the scheduled payments that are available to the PAC bonds, assuming an initial collar of 85% and 300% PSA, and FNMA 9% collateral with a WAC of 9.76% and

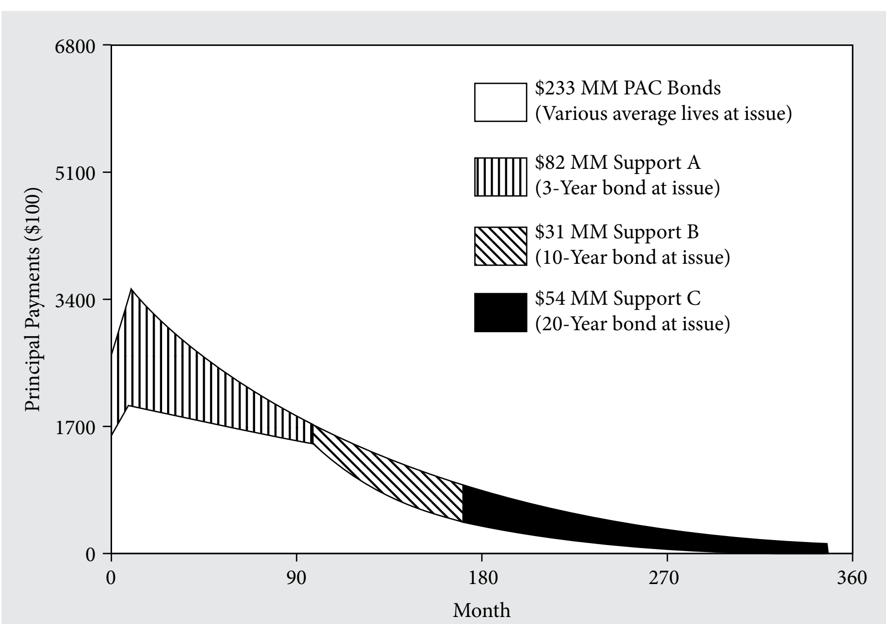

FIGURE 15.1 PAC with standard support bonds, 165% PSA

a weighted-average maturity (WAM) of 339 months. Normally, a structurer would divide the PAC cash flow into a number of PACs with varying average lives—a sequential PAC structure. The actual number of PACs created would depend on the demand for each particular maturity and window structure (the time elapsed between first and last principal payments to the PAC bondholders). For ease of exposition, the PAC cash flow in this and subsequent examples is not divided. The support bonds are not influenced by the partitioning of a PAC cash flow into individual bond classes; they are affected, instead, by the size of the entire region in relation to the total size of the support bond classes. (In general, the larger the PAC class, given a fixed amount of collateral, the more volatile the support bond class.) The principal payments left over after the PAC region is defined constitute the support bond classes. In Figure 15.1, these are depicted by the shaded areas. At a pricing prepayment assumption of 165% PSA, the support bonds pay sequentially over the entire remaining life of the collateral. In this example, the support bond paydowns at 165% PSA have been divided into three sequential classes with average lives of 3.1, 11.5, and 20.3 years (nominally a series of 3-, 10-, and 20-year bonds).

The impact of actual prepayment experience on the size and timing of principal payments to the support bond classes is graphically depicted in Figures 15.2 and 15.3. When prepayments occur at a constant speed of 300% PSA (the upper PAC collar), as shown in Figure 15.2, the PAC schedule is unaffected. However, the support bonds shorten dramatically and are all fully retired by the eighth year. Conversely, Figure 15.3 shows that

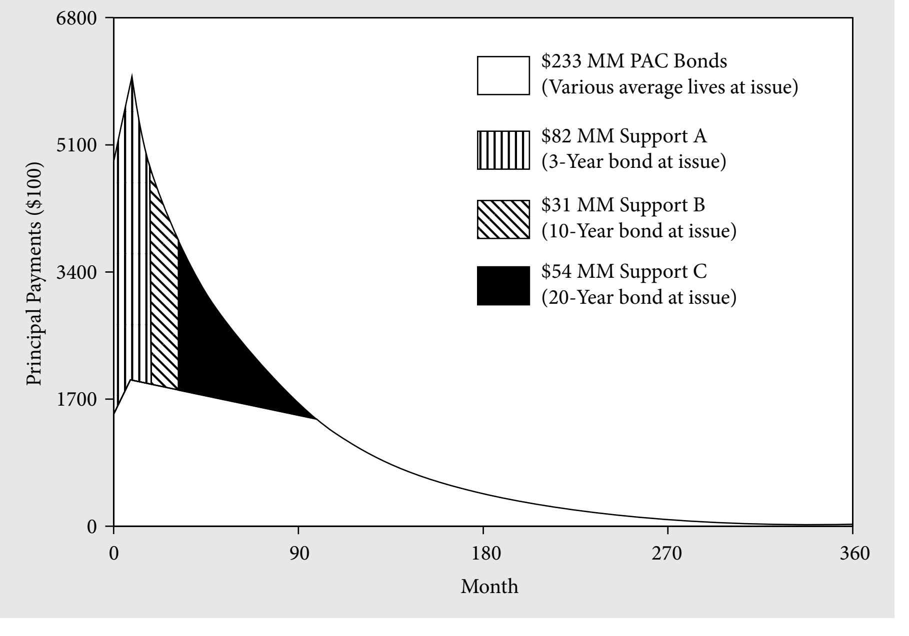

FIGURE 15.2 PAC with standard support bonds, 300% PSA

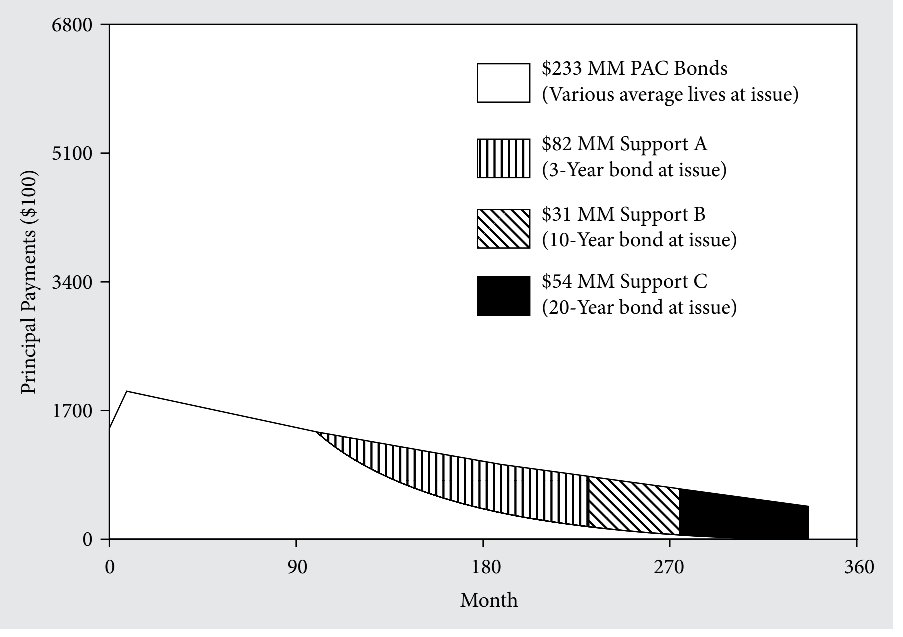

FIGURE 15.3 PAC with standard support bonds, 85% PSA

when prepayments slow to 85% PSA (the lower PAC collar), the first support bonds do not begin to pay until about the eighth year.

The resultant average-life volatility is very significant. Given a 300% PSA prepayment rate, bonds with an average life at a pricing of 3, 10, and 20 years shorten to 1.0, 2.5, and 5.8 years, respectively. Conversely, at 85% PSA, the same bonds report average lives of 15.0, 21.1, and 25.6 years, respectively. The average-life variability of a support bond is generally a function of the following:

- The size of the PAC principal balance relative to the entire issue.
- The size of the support bond relative to the remaining support bonds, and its average life at the pricing prepayment assumption.

A detailed examination of how these characteristics interact to produce the actual behavior of support bonds in different prepayment scenarios is beyond the scope of this chapter. Nonetheless, it is worth outlining the basic relationships between support bond structure and behavior because they apply as well to the more complex, schedule-based structures that are the subject of this chapter.

The order in which a support bond is scheduled to receive excess cash flows also can profoundly affect its average-life behavior. Most investors normally assume that the support bonds will be retired in the order of their average lives at issue and that the order of priority does not change over the term of the transaction (indeed, this assumption is made throughout this discussion). This assumption, however, could be altered by structural nuisances, generating results that are entirely specific to the transaction in question. Rather than assume that a certain order of priorities is standard, the investor should assure herself that she understands the priorities and principal payment rules on which the structure is based, as well as the conditions under which the return of principal may be accelerated or delayed.

There are basically three different ways to vary the relative size of the support bonds. These are:

- Lockouts, already mentioned above, are typically employed to improve the stability of payments to the earliest support bond class in the structure. Moreover, with two or three years of scheduled paydowns added to its size, the first support bond class can provide a buffer against both call and extension for subsequent support bond classes.
- A similar technique is to pay the later years or "tail" of the PAC schedule to the support bonds which are projected to receive principal at the same time. Both intermediate-and long-term support bonds can benefit from this technique.
- The third, tightening the collars, can increase the size of the support bonds. Raising the bottom collar increases the principal available to pay the support bond classes in the early years (generally the first quarter to first third of the remaining term of the collateral) and lowering the top collar increases principal in later years.

It also should be apparent that the smaller the scheduled PAC principal payments, the more principal is available to the support bond classes at any given prepayment speed, reducing both extension and call risk. The smaller the PAC region, the larger the projected paydowns to the support bond in any one period and the smaller the excess principal as a proportion of the projected support bond's principal payment. In other words, excess principal has a proportionally smaller impact on the dollar weights used to compute the support bond's average life.

For similar algebraic reasons, changing the proportion of PACs, while holding the average lives of the companion bonds about the same, has a bigger impact on the volatility of support bonds constructed from tail (last) cash flows because smaller dollar weights are applied to later dates. The absolute magnitude of the average life at issue of a support bond also determines the magnitude of extension and call risk. This is also very intuitive: the longer the average life at issue, the less room to lengthen and the more room to shorten. Similarly, short-term bonds have less room to shorten, more to lengthen.

The shortening of a CMO bond's average life in a bull market or, conversely, its lengthening in a bear market generally are, for the most part, negative events from the investor's point of view. Two effects are of particular concern.

- The additional cash flow accelerates or decelerates at the wrong time. As a consequence of the interest rate sensitivity of the prepayment process, reinvestment

opportunities are most likely to have declining yields when prepayments are increasing, and rising yields when prepayments are drying up.
- As the average life of the companion changes, so too does the bond's duration or price sensitivity. In a bull market, the bond's price appreciates more slowly as market yields decline, generating a lower economic return than a bond of like but stable average life. In a bull market, the support bond's value depreciates more quickly as yields rise.[4]

Given that support bonds absorb prepayment volatility from the PAC bonds, changes in expected average life resulting from changes in prepayment experience in the collateral are of heightened concern to companion bond investors. Consequentially, an accurate model of the prepayment process under various interest rate scenarios is even more valuable in the evaluation of support bonds. Without appropriate prepayment projections, such as those derived from an econometric prepayment model, it is impossible to link changes in interest rate levels to meaningful estimates of the yield or total rate of return of a support bond.

Support TAC Bonds

Support TAC bonds, first introduced in the third quarter of 1988, have proved to be a highly marketable innovation. From their inception, the market quickly evolved away from TAC only structures to support TACs, and clean TAC bonds (from structures without PACs); consequently, TAC only structures are infrequently created.

A TAC schedule is created by projecting the principal cash flows for the collateral at a single constant prepayment speed. This speed is typically the prepayment speed at which the transaction is priced. In the case of a clean TAC, the projected principal payments define the schedule. In the case of the support TAC, projected principal remaining after scheduled PAC payments are made defines the schedule. The TACs have first priority after the PACs to principal payments, and their schedules are protected from call risk by the existence of other support classes that absorb any principal paydowns exceeding both the scheduled PAC and TAC payments in any period. The larger these "support" classes are in relation to the support TAC, the greater the protection provided to the TAC schedule.

Compared to a clean TAC with similar (in the example they are the same) average life and underlying collateral, the support TAC necessarily receives less protection, because a larger proportion of the total collateral has already been allocated to the higher-priority PAC bonds, and a much smaller proportion of principal remains to be allocated to lower-priority support tranches.

[4] A structurer can improve the appeal of volatile securities to some investors by manipulating the coupon so that they are priced as deep discounts to benefit from fast prepayment speeds or as high premiums to benefit from slow prepayments.

For this discussion, a simplified example of a support TAC was created from the 3-year support bond in Figure 15.1. This was done simply by defining a schedule as the principal payments to the 3-year support bond, assuming a constant prepayment speed of 165% PSA. Since it is identical at 165% PSA to the PAC-standard support bond example, see the cash flow diagram in Figure 15.1 to understand this structure. The impact of faster prepayments on this PAC–TAC structure is shown in Figure 15.4. At 300% PSA, the higher priority given to the TAC schedule forces both the 10- and 20-year support bonds to pay down simultaneously with the TAC (instead of sequentially as in the first example). Note that the shape of the support TAC at 300% PSA is almost but not entirely identical to its shape at 165%, indicating that the schedule is still well protected at this speed. The size and timing of later payments has been altered slightly at the higher prepayment speed for reasons discussed below.

Support TACs generally have the same properties as clean TACs: they provide a degree of call protection and little extension protection. Many structures actually first exhibit extending average life, when prepayments slightly exceed the TAC speed, before the average life shortens at higher speeds. The important difference is that support TACs have significantly less call protection since they must absorb excess principal once the remaining unscheduled support bonds are retired. Table 15.1 highlights the aforementioned, illustrating the average-life profile of different 3-year CMO structures given various repayment speeds. For comparison, a clean TAC with a 3.1-year average life has been constructed from the same collateral used to create the PAC-standard support and PAC–TAC examples.

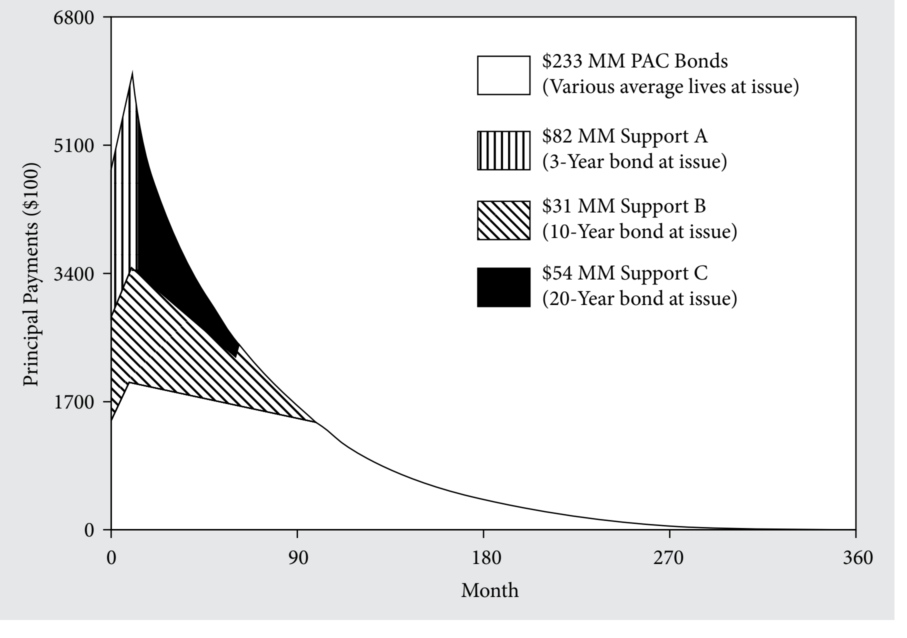

FIGURE 15.4 PAC with standard support TAC, 300% PSA

Table 15.1 Average lives at various prepayment speeds of different 3-year PAC–support structures (pricing assumption 165% PSA)

Prepayment Speed (% PSA)	Average Life (years)			
	Clean TAC	PAC Support	Support TAC	Level II PAC
0	16.7	24.7	24.7	23.3
50	8.0	19.9	19.9	16.8
85	6.0	14.9	14.9	9.5
90	5.2	13.7	13.7	3.1
125	4.0	7.2	7.2	3.1
165	**3.1**	**3.1**	**3.1**	**3.1**
225	3.1	1.6	3.1	3.1
275	3.1	1.2	3.1	2.7
300	3.1	1.0	3.2	2.5
475	3.1	0.6	1.6	1.5
600	3.1	0.5	1.2	1.1

- The clean TAC offers exceptional call protection (it is protected by $360 million of support bonds, which comprise the remainder of the structure). The smaller size of the clean TAC also results in its having a lower average life at very low prepayment speeds than the support TAC does (the clean TAC is small enough for even small paydowns at low speeds to reduce its principal balance significantly in the early years).
- The more important comparison, since so few clean TACs are issued, is relative to the 3-year support from Figure 15.1. The support TAC clearly provides meaningful call protection, requiring speeds in excess of 600% PSA before it shortens as much as the standard support bond does at 300% PSA. Both bonds extend identically due to the fact that their principal payment priority is equal after the PACs to receive principal paydowns and there are no support bond classes in front of them (the TAC would have priority over an earlier support bond class, which would protect it to a degree from extending, whereas the standard support bond would wait until earlier support bond classes were retired, which would cause it to extend).

Notice that at 300% PSA, the support TAC's average life is about a month longer than at the pricing speed (rounding exaggerates the difference—at several more places of significance the difference is really about 0.08 year). This phenomenon occurs at relatively high speeds, because principal payments are bunched in the early months and taper off sharply in later months. Figure 15.4, as mentioned above, gives some indication of what

Table 15.2 Average lives at various prepayment speeds of 20-year supports from different CMO structures (pricing assumption 165% PSA)

Prepayment Speed (% PSA)	Average Life (years)		
	PAC Structure	PAC/TAC Structure	Layered PAC Structure
0	27.7	27.7	27.8
50	26.8	26.8	27.0
90	25.3	25.3	25.6
125	23.3	23.4	23.3
165	**20.3**	**20.3**	**18.2**
190	18.0	18.0	12.5
225	13.6	13.1	5.1
250	10.4	9.2	3.8
275	7.4	5.7	3.1
300	4.8	2.6	2.6
475	2.0	1.0	1.3
600	1.5	0.7	1.0

is happening at this speed to the principal cash flows thrown off by the collateral. The paydowns become more "tailish" toward the end of the support bond's schedule, forcing it to wait as excess payments are, going into the tail, not large enough to meet the schedule.

Another difference between PAC–TAC structures and both clean TAC and PAC-standard support bond structures is the greater average-life volatility of the PAC–TAC unscheduled support bond relative to that of clean TAC or PAC support bonds. The presence of additional risk-reduced classes like a scheduled TAC forces the remaining unscheduled support bonds to absorb more prepayment volatility. This is demonstrated in Table 15.2, where various 20-year support bond structures are compared. At prepayment speeds above 225% PSA, the support bond in the PAC–TAC structure begins to shorten more quickly than that of the standard support bond.

Reverse TACs

Payment rules and priorities can also be devised so as to protect a support bond from extension risk while leaving it more exposed to call risk. These structures fittingly are termed "reverse TACs." Reverse TACs are, by their nature, bearish structures designed to protect the investor from extension risk in a rising interest rate environment. These structures typically are created as 20-year support classes. Their long lives make them natural candidates for this treatment, as they have not, in any case, more than six or maybe eight years to extend. Additionally, reverse TACs are often priced at a discount from par so that the structure will also benefit from an increase in prepayments.

An example of a reverse TAC was created for this discussion by defining a payment schedule for the fourth tranche of the PAC–support bond structure depicted in Figures 15.1, 15.2, and 15.3. A cash flow diagram for prepayments at 85% PSA is included in Figure 15.5. Note the following:

- The reverse TAC schedule was set at 165% PSA, the pricing speed in all these examples, and has priority after the scheduled PAC payments are made.
- The PAC–reverse TAC structure pays exactly like that of the PAC standard support bond depicted at both 165% PSA (Figure 15.1) and 300% PSA (Figure 15.3).
- The reverse TAC receives excess cash flow only after the 3- and 10-year support bonds are retired.

Taken together, the above preserve the reverse TAC schedule at a prepayment speed slower than that used to generate its schedule. However, the reverse TAC schedule is not preserved at a faster speed. The reverse TAC does not begin to extend until prepayments fall below a constant rate of about 70% PSA.

Table 15.3 compares the average-life volatility of the reverse TAC to those of other 20-year support bond structures. Given a prepayment speed of 85% PSA, the reverse TAC has an average life of 20.3 years. Under the worst-case assumption, that of no

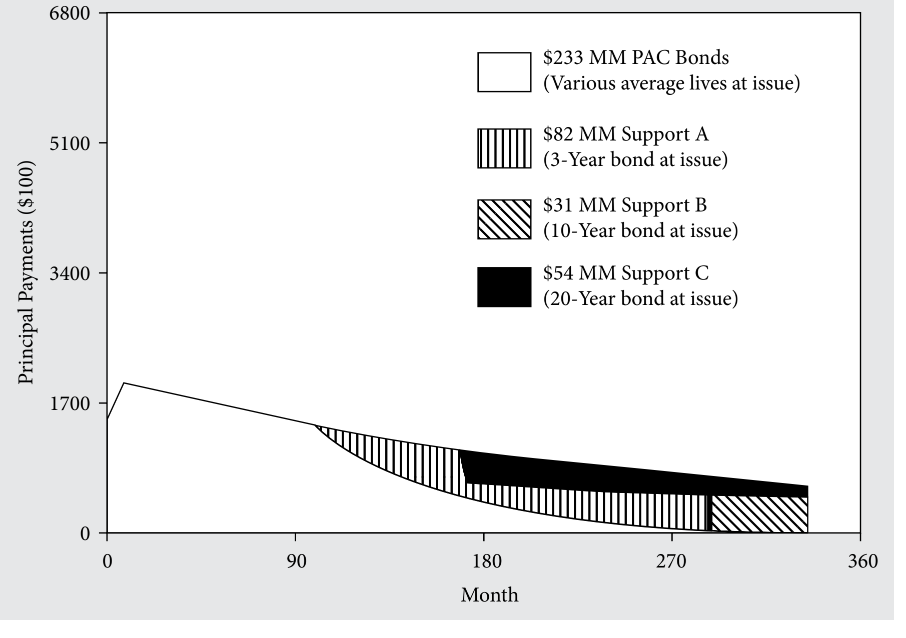

FIGURE 15.5 PAC with reverse TAC bond, 85% PSA

Table 15.3 Average lives at various prepayment speeds of 20-year PAC structures (pricing assumption 165% PSA)

Prepayment Speed (% PSA)	Average Life (years)		
	PAC Support	Reverse TAC	Level II PAC
0	27.7	24.5	24.6
50	26.8	20.7	20.3
85	25.6	20.3	18.1
125	23.3	20.3	18.1
165	**20.3**	**20.3**	**18.1**
190	18.0	18.0	18.1
225	13.6	13.6	18.1
250	10.4	10.4	14.7
275	7.4	7.4	8.6
300	4.8	4.8	5.8
350	3.3	3.3	3.7
475	2.0	2.0	2.2
600	1.5	1.5	1.6

prepayments, its average life only extends to 24.5 years. By comparison, the last bond class of the simple PAC–support bond structure extends to 27.7 years. The cash flow diagrams presented in Figures 15.3 and 15.5 help to clarify the relative cash flow performance between the two.

- In the simple PAC–support bond structure (Figure 15.3), at a speed equal to the upper collar, the support bonds pay down sequentially once the PAC bonds are retired.
- In the reverse TAC structure (Figure 15.5), both the 3- and 10-year support bonds extend to maintain the scheduled reverse TAC. At 85% PSA, the lower PAC collar, the short- and intermediate-term support bonds pay simultaneously with the reverse TAC. At slower prepayment speeds, the average lives of both support bonds exceed that of the reverse TAC.

The reverse TAC imparts considerably more volatility to the other support bonds when prepayments slow, but it does not cause them to be more volatile in faster prepayment scenarios. This effect can also be seen by comparing the average lives of 3-year support bonds from both structures listed in Table 15.4. This is a natural consequence of the one-sided protection afforded by TAC structures.

Schedules can also be applied to intermediate-term support bonds to protect their average lives from extending in slow prepayment scenarios. At the same time, the

Table 15.4 Average lives at various prepayment speeds of 3-year support bonds from different CMO PAC structures (pricing assumption 165% PSA)

Prepayment Speed (% PSA)	Average Life (years)		
	PAC Structure	PAC/Reverse TAC Structure	Layered PAC Structure
0	24.7	26.3	26.1
50	19.9	22.7	22.7
85	14.9	16.5	18.3
90	13.7	15.0	17.4
100	11.5	12.4	14.5
125	7.2	7.2	8.7
165	**3.1**	**3.1**	**3.1**
225	1.6	1.6	1.5
275	1.2	1.2	1.1
300	1.0	1.0	1.0
475	0.6	0.9	0.6
600	0.5	0.6	0.5

structure is "protected" from call risk in moderately fast prepayment scenarios by taking advantage of the natural tendency of TACs to extend slightly as prepayments exceed the pricing speed. The resulting average-life profile is reasonably stable across a significant range of prepayment speeds (for example, extending no more than two or three years across a range from 50% or 75% PSA to 225% or 250% PSA, assuming a principal payment schedule set at 165% PSA). In effect, an intermediate-term support TAC can be constructed to provide PAC-like stability.

Layered PAC Bonds

The value of support classes also can be enhanced by establishing secondary PAC schedules for a portion of the principal remaining after the primary PAC payments are met. A cash flow diagram for an example of a two-tiered PAC structure, run at a pricing speed of 165% PSA, is shown in Figure 15.6.

The example uses the same collateral as that presented in the previous examples. The same collars—85% to 300% PSA—were used to create the same principal balance of primary or Level I PACs—$233 million of a total original balance of $400 million CMO bonds. The collars of the second tier of PACs are set at 90% and 225% PSA. The second-tier PAC region was further divided into a series of nominally 10- and 20-year bonds

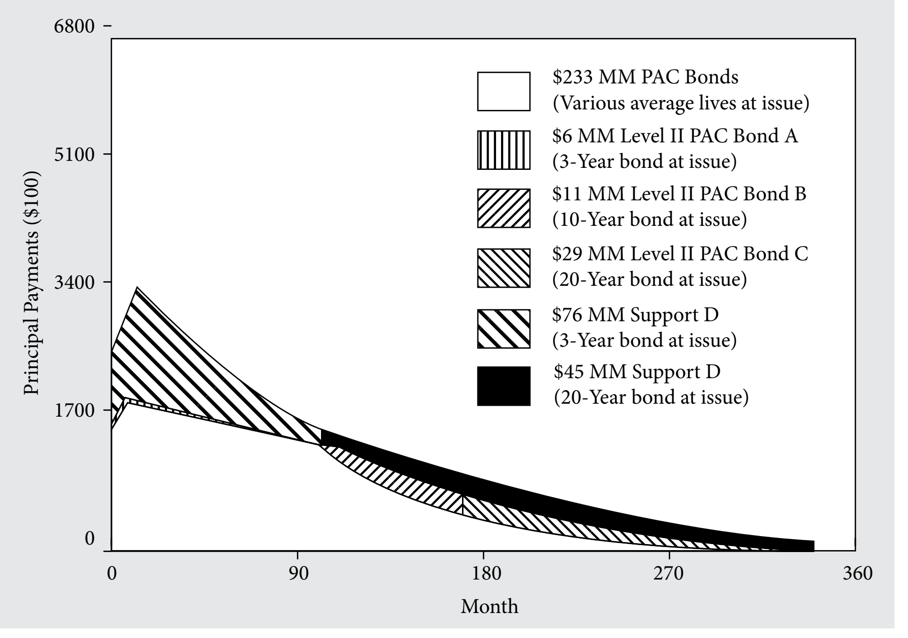

FIGURE 15.6 Layered PAC structure, 165% PSA

and the support bonds into three- and 20-year bonds. (In order to match the 3.1-year average lives in the previous examples, it was necessary to let the long-term bonds in the layered PAC example have average lives closer to 18 than to 20 years. This does not vitiate the comparison.)

The Level II PACs appear in Figure 15.6 as a narrow collar between the PAC region and the support bonds. At 165% PSA they pay down simultaneously with the primary PACs in the deal. The size of the second tier of PACs is a function of the collars—the tighter the protection collar, the larger the amount of PACs that can be created. In this example, protecting the Level II schedule up to 225% PSA limits the amount of 3-year Level II PACs that can be created to $5.6 million. In total, the second layer of PACs only amount to about 11% of the transaction (58.25% of the transaction is standard Level I PACs).

The Level II PAC schedule remains intact until prepayment speeds break the primary PAC collars. For example, Figure 15.7 shows the principal payments at 300% PSA. At this speed, the primary PAC schedule is not violated, but payments to the Level II PACs are significantly accelerated, shortening to average lives of 2.5, 3.9, and 5.8 years, respectively. Similarly, when prepayments slow to a constant speed of 85% PSA, primary PAC payments are made on schedule, but the payments to Level II PACs are delayed. At 85% PSA—Figure 15.8—the support PACs have average lives of 9.5, 11.3, and 18.1 years, respectively. As expected, the longer Level II PACs are more volatile on the upside, when prepayments accelerate, and the shorter PACs are more volatile on

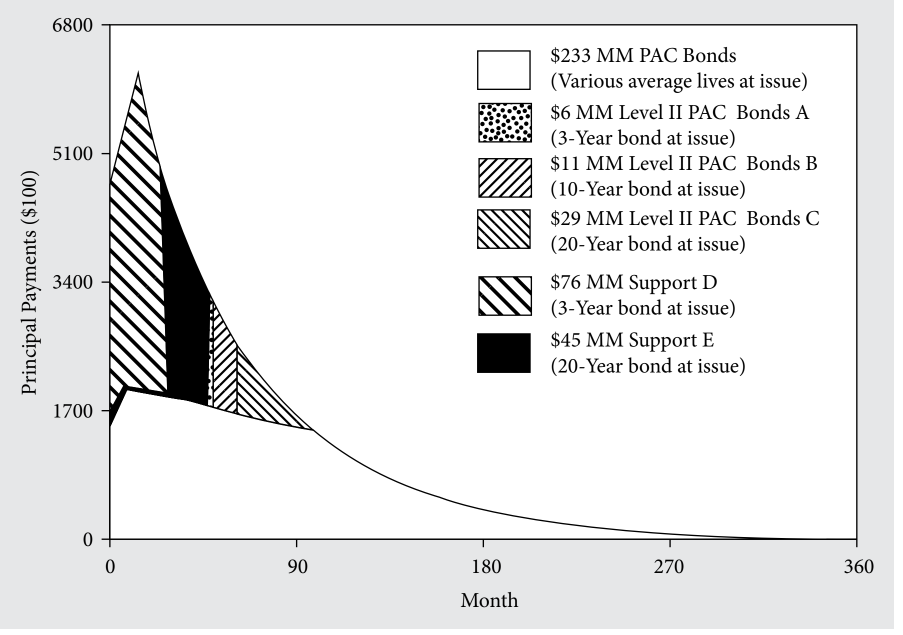

FIGURE 15.7 Layered PAC structure, 300% PSA

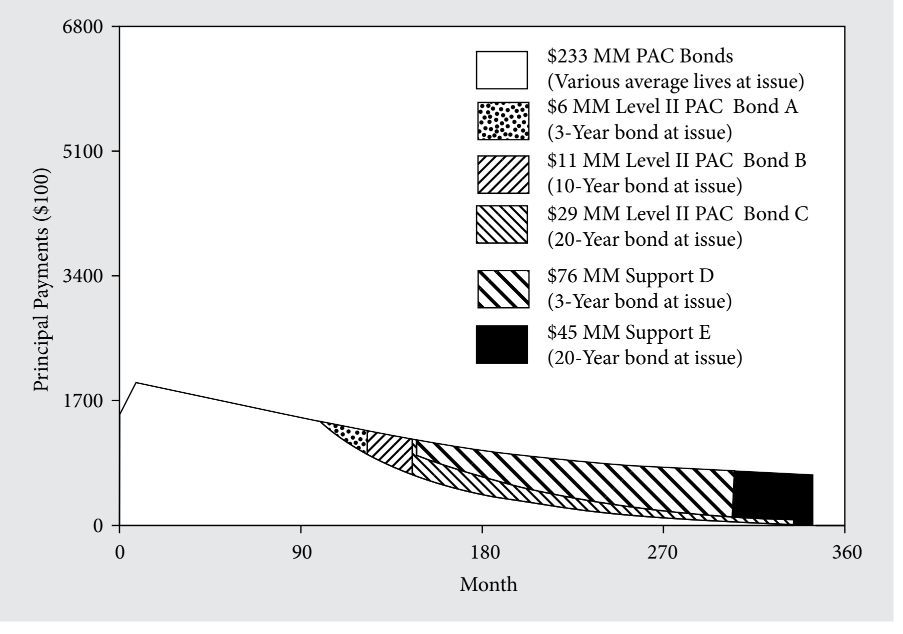

FIGURE 15.8 Layered PAC structure, 85% PSA

the downside, when prepayments decelerate. The 3- and 20-year bonds receive no principal until the Level II PACs are paid, extending their average lives to 18.3 years and 25.8 years, respectively.

Table 15.3 compares the average-life volatility of Level II PACs to that of support TACs and a 3-year standard support bond. Although not as well protected as primary PACs, Level II PACs do provide modest call protection and decent extension protection. Moreover, these examples demonstrate that they can shorten and extend less vigorously than their TAC and reverse TAC counterparts when prepayments move outside the respective protective boundary. The support bonds of layered PACs are somewhat more volatile over moderate prepayment shifts. Table 15.2 compares the 20-year standard PAC support bond, reverse TAC bond, and layered PAC support bond. It shows that the 20-year bond shortens faster between 165% and about 250% PSA than either of its counterparts. Similarly, Table 15.4 indicates that the 3-year layered PAC support lengthens more abruptly than its counterparts at prepayment speeds between 165% and 50% PSA.[5]

Summary of Average-Life Volatility

The average-life volatilities of the 3-year support bond structures discussed in this chapter are summarized in Figure 15.9, as are those of the 20-year supports in Figure 15.10. The graphs make clear the differences in call and extension protection that can be provided by furnishing support classes with TAC or PAC schedules. In summary:

- The Level II PACs have stable average-life patterns between the upper and lower collar speeds. (A Level I PAC would have a similar pattern, only it would be stable over a wider range, say 75% to 300% PSA, and owing to the presence of the supports, would shorten or lengthen more moderately outside that range.)
- By comparison, the standard support bonds demonstrate steep and continuous changes in average life over the same ranges for which the Level II PACs are protected.
- The TACs, as expected, provide call protection, but no extension protection, while the reverse TACs are stable at slower speeds, but shorten abruptly when prepayments occur at faster constant rates than the prepayment assumption.

[5] Bear in mind that all these examples are highly simplified and furnish only a basic understanding of how the structures behave. Actual CMO issues are frequently more complex, containing other structures or variations on those discussed in this chapter. Additional complexity could result in behavior significantly different from these examples.

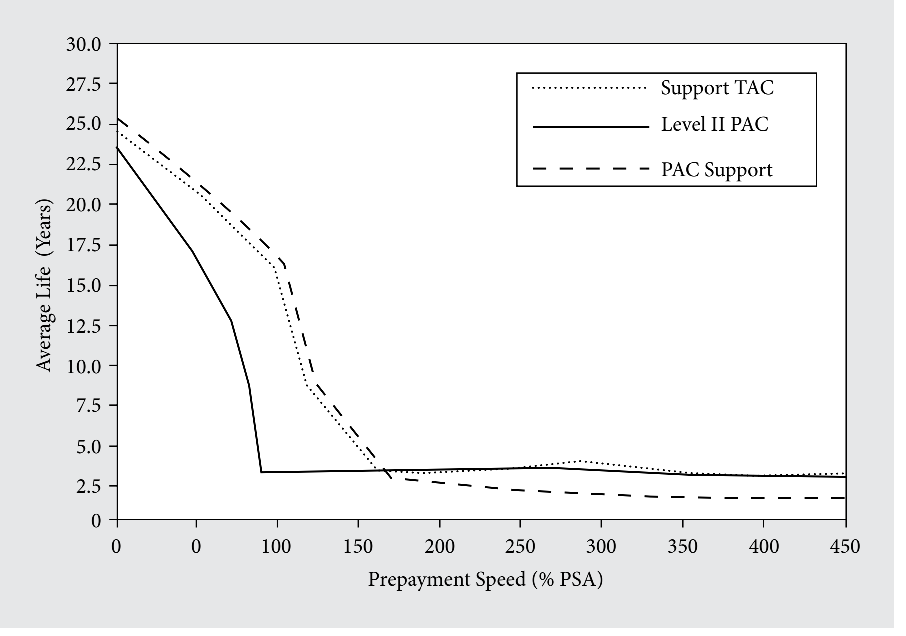

FIGURE 15.9 Different 3-year CMO support structures (average lives over a range of conditional prepayment speeds)

Note: The average lives of the support TAC and PAC support bond are the same between 0% and 165% PSA; the lines have been separated for readability

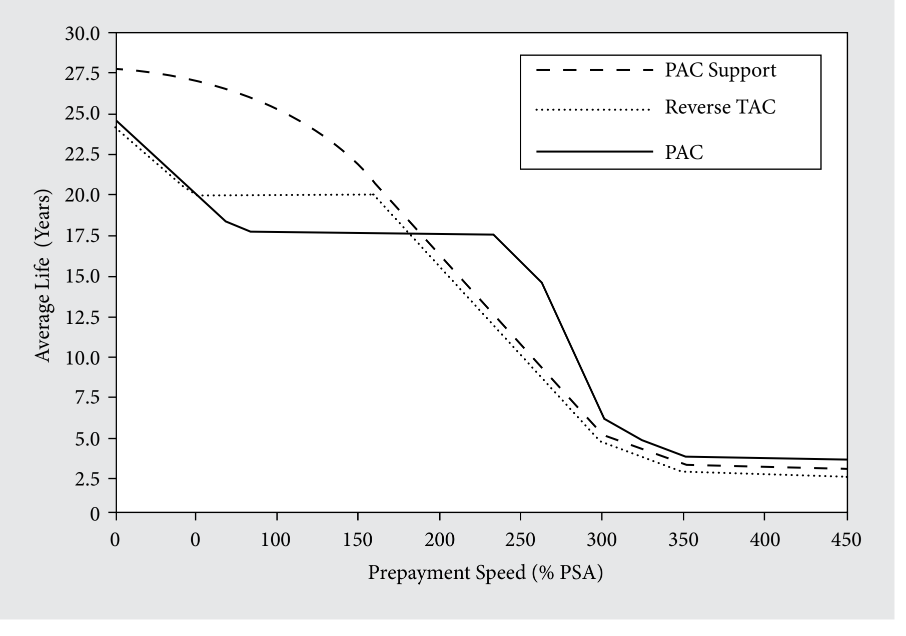

FIGURE 15.10 Different 20-year CMO support structures (average lives over a range of conditional prepayment speeds)

Note: The average lives of the PAC support and reverse TAC are the same at prepayment speeds above 165% PSAs. The lines are separated for readability

Key Points

- Support bonds (also referred to as companion bonds) are the natural byproduct of creating PAC bonds.
- The cash flow for support bonds can be structured with a schedule in much the same way that level I PAC and TAC structures are created.
- Structurers have developed a variety of devices that serve either to reduce the risk of a portion of the support classes or to create more volatile instruments that reward holders when interest rates (and presumably prepayment rates) move strongly in a particular direction.
- The order in which a support bond is scheduled to receive excess cash flows also can profoundly affect its average-life behavior.
- Support bonds with schedules offer the investor greater cash flow certainty relative to that of support with no schedule by transferring greater prepayment risk to the remaining unscheduled support in the deal.
- Scheduled support bonds can be structured to provide both extension and call protection (level II PAC), call protection (TAC), or extension protection (reverse TAC).

CHAPTER 16

FLOATING-RATE MORTGAGE SECURITIES

AIRAT CHANYSHEV, ERIN MCHUGH,
AND ESTHER BRUEGGER

After reading this chapter you will understand:

- the types of floating-rate mortgage securities and their structural characteristics;
- mechanisms for creating a floating-rate mortgage security backed by fixed-rate collateral;
- investment characteristics and risks of floating-rate mortgage securities;
- factors affecting the valuation of floating-rate mortgage securities and metrics used to analyze their value;
- historical issuance trends for floating-rate mortgage securities.

Floating-rate securities are an important segment of the mortgage securities markets. In 2014, more than $90 billion in floating-rate mortgage securities were issued. Some of the risks inherent in securities collateralized by mortgages (e.g., interest rate risk and prepayment risk) are mitigated when the securities are structured as floaters. The purpose of this chapter is to explain the different types of floating-rate mortgage securities, their structural characteristics, and their valuation. This chapter also provides an overview of the current floating-rate mortgage securities markets.

Introduction to Floating-Rate Mortgage Securities

Floating-rate securities (or floaters) are securities with coupon (or interest) rates that periodically change over the life of the instrument. Floating-rate mortgage securities are floaters that are collateralized by mortgage loans or (other) mortgage securities, and include passthroughs backed by adjustable-rate mortgages (ARMs) and floating-rate tranches of collateralized mortgage-obligations (CMOs).

Structural Characteristics of Floating-Rate Mortgage Securities

The coupon rate on floaters is typically reset periodically (e.g., monthly) using an applicable reference rate. The reference rate (or index) is usually a short-term money market interest rate. Floors and/or caps can be used to restrict the range of the coupon rate on a floater.

Coupon Formula

The coupon formula for a floating-rate security typically involves a reference rate and a quoted margin, as follows:

Coupon rate = reference rate + quoted margin

LIBOR rates[1] are the most widely used reference rates. For example, the applicable reference rate for a floater could be 1-month LIBOR. Other benchmark rates that are used include US Treasury yields of various maturities and the 11th District Federal Home Loan Bank Cost of Funds Index (COFI).

The *quoted margin* (QM) is the adjustment to the reference rate, which can be positive or negative; in other words, the coupon rate may be higher or lower than the reference rate. The quoted margin is set at issuance of the floater and is determined using then-current market conditions. For example, the applicable quoted margin could be 50 basis points (bps). In this case:

Coupon rate = 1-month LIBOR + 50 basis points

Assuming a monthly reset date, the coupon would reset to 50 basis points (or half of a percentage point) higher than 1-month LIBOR each month.

For some floating-rate securities (referred to as *stepped-spread floaters*) the quoted margin changes (i.e., "steps" to a higher or lower level) during the term of the security.

Caps and Floors

The coupon rate on a floating-rate security may be subject to a cap, a floor, or both. A *cap* is a restriction on the maximum coupon rate that can be set at a reset date (putting an upper bound on the rate of interest that will be payable). A *floor* is a restriction on the minimum coupon rate that can be set at a reset date (putting a lower bound on the rate of interest that will be payable).

[1] LIBOR (London Interbank Offered Rate) provides an indication of the average rate at which a LIBOR contributor bank can obtain unsecured funding for a given period in a given currency. See "ICE LIBOR," available at <https://www.theice.com/iba/libor>, accessed July 14, 2015.

Mechanisms for Structuring a Floating-Rate Mortgage Security

Most floating-rate mortgage securities can be broadly classified into two categories: (1) agency mortgage passthrough securities backed by adjustable-rate mortgages, and (2) floating-rate tranches of CMOs (both agency and non-agency), which we will refer to as CMO floaters.[2]

Agency ARM Passthrough Securities

ARMs are mortgage loans with a floating rate: that is, an interest rate that is adjusted periodically, possibly after an initial fixed interest rate period. Passthrough securities backed by ARMs are effectively floating-rate securities, as the floating-rate payments made on the underlying mortgages are passed through to the security holders. The agencies[3] (Ginnie Mae, Fannie Mae, and Freddie Mac) all have programs that pool ARMs and issue passthrough securities[4] backed by those mortgages. Table 16.1 lists examples of the types of ARM passthroughs issued by Fannie Mae.

Table 16.1 Common Fannie Mae ARM passthroughs

Common Fannie Mae ARM MBS

Initial Fixed Interest Rate Period/Adjustment Frequency	Indices Available	Cap Structure: % @ Initial Adjustment/% @ Subsequent Adjustment/% over Life of Loan
6 Month (six months/ semiannual)	6-Month *Wall Street Journal* LIBOR	1/1/6
1/1 (one year/annual)	1-year LIBOR, 1-year (CMT) Treasury	2/2/6
3/1 (three years/annual)	1-year LIBOR, 1-year (CMT) Treasury	2/2/6
5/1 (five years/annual)	1-year LIBOR, 1-year (CMT) Treasury	5/2/5, 2/2/5, 2/2/6
7/1 (seven years/annual), 10/1 (10 years/annual)	1-year LIBOR, 1-year (CMT) Treasury	5/2/5

Source: Fannie Mae, "Basics of Fannie Mae Single-Family MBS," last updated August 5, 2013, available at <http://www.fanniemae.com/resources/file/mbs/pdf/basics-sf-mbs.pdf>, accessed July 14, 2015. Used with permission.

[2] CMOs are also referred to as REMICs. Non-agency CMOs are often referred to as non-agency (or private-label) residential mortgage-backed securities (RMBS) by market participants.

[3] The agencies are the Government National Mortgage Association (Ginnie Mae), the Federal National Mortgage Association (Fannie Mae), and the Federal Home Loan Mortgage Corporation (Freddie Mac).

[4] Passthrough securities are almost exclusively issued by the agencies. Most non-agency deals are structured as CMOs. Ginnie Mae and Fannie Mae passthroughs are called mortgage-backed securities (MBSs). Freddie Mac passthroughs are called participation certificates (PCs).

The underlying ARMs for each passthrough have the same reference rate and the same initial fixed interest rate period. (This initial fixed rate is also called a "teaser" rate because the rate is typically low.) For example, 5/1 ARMs (ARMs with a five-year initial fixed interest rate period and thereafter an annual adjustment frequency) are only pooled with other 5/1 ARMs. Other pooling requirements include the same original interest-only period, the same amortization period, and the same interval between adjustments.[5]

Freddie Mac also offers Giant PCs, including ARM Giant PCs, which are ARM passthroughs that consolidate other ARM PCs into larger passthroughs.

Since underlying mortgages with different interest rates may prepay differently, prepayments can affect the coupon that is passed through to the investors. Note that ARMs have both periodic caps (caps on how much the interest rate can be increased at a given reset) and lifetime caps (caps on how high the interest rate can be set at any reset date over the term of the mortgage).

CMO Floaters

Agency CMOs are collateralized by agency passthrough securities. Non-agency CMOs are generally collateralized by mortgage loans. CMO tranches are classified by the manner in which they make principal and interest payments. Most agency CMO floaters fall into one of the following principal payment categories: passthrough, planned amortization class (PAC), accretion-directed (AD), sequential, or support; passthroughs are the most common. Note the terminology: when talking about an agency CMO tranche (e.g., an agency CMO floater), "passthrough" means that the tranche principal is paid pro rata from principal payments of the underlying agency passthroughs.[6]

CMOs can be structured to include floating-rate tranches, even when the underlying collateral pays a fixed rate. This is typically done by pairing a floating-rate tranche with an inverse floating-rate tranche. An *inverse floater* is a tranche with a coupon rate that changes inversely with the reference rate (i.e., decreases when the reference rate increases, and vice versa). Alternatively, for non-agency CMOs, an interest rate swap can be used to create floaters backed by fixed-rate collateral.[7]

Let us consider an example of a CMO backed by $100 in collateral paying a 5% coupon rate. One can distribute the annual cash flows from the collateral to a floater and an inverse floater in the manner shown in Table 16.2.

The interest rate on either tranche cannot be negative. In order to ensure this, the coupon rate of the floater (LIBOR+QM) has a cap. The level of the cap largely determines the structure of the floater. The higher the cap (relative to the interest rate on the collateral), the smaller the principal of the floater must be.[8]

[5] See, for example, the complete pooling requirements for Freddie Mac ARMs, available at <http://www.freddiemac.com/mbs/docs/wac-arm_pool-parameters.pdf>, accessed July 14, 2015.

[6] For passthrough CMO tranches, interest payments can be classified into fixed, floating, inverse floating, inverse IO, principal only, and others.

[7] An interest rate swap would convert the underlying fixed-rate mortgage payments to floating-rate payments for the holders of the CMO floater; in that case, all of the CMO tranches can be floaters.

[8] If the principal of the collateral and the floater were equal (say, $100) and if the cap on the floater exceeded the coupon rate on the collateral, this could result in a situation where the interest paid on the collateral was insufficient to cover the interest owed to the floater.

Table 16.2 Hypothetical CMO Structure: Formulas

Cash Flows	Collateral	Floater	Inverse Floater
Principal	$100	PrinFl	$100 – PrinFl = PrinInv
Interest	$5	PrinFl*(LIBOR+QM)	$5 –PrinFl*(LIBOR+QM)

Table 16.3 Hypothetical CMO Structure: Numerical Example

Cash Flows	Collateral	Floater	Inverse Floater
Principal	$100	$71.43	$28.57
Interest	$5	$71.43*(LIBOR+QM)	$5–$71.43*(LIBOR+QM)*

Note: *$71.43 = $28.57 * 2.5.

For example, if the cap is set at 7%, then the principal of the floater (PrinFl) will be set at $100*(5%/7%) = $71.43.[9] Principal of the inverse floater (PrinInv) will then be set at $28.57 as shown in Table 16.3.

Note that the ratio of the two principal amounts (PrinFl/PrinInv) = $71.43/$28.57 = 5%/(7%–5%) = 2.5 is called the *multiple* (or *coupon leverage*). The total coupon on the inverse floater is then $5–2.5*PrinInv*(LIBOR+QM), and the coupon rate on the inverse floater can be written as 2.5*(7% – QM) – 2.5*LIBOR.

One can see from these formulas that another component of the structure that needs to be determined at the time of structuring is the quoted margin (QM). The QM is usually set such that the floater is priced at par at issuance.

Figure 16.1 shows how the coupons of the two tranches in this example (floater and inverse floater) change with moves in LIBOR.[10] Note how high the coupon on the inverse floater becomes when LIBOR is low.

Figure 16.2 shows how the multiple and the principals of the two tranches in the example change with a change in the floater cap. As the cap increases, the multiple and the size of the floater tranche decrease, while the size of the inverse floater tranche increases.

A floater can also be created from fixed-rate collateral using a floater/inverse floater interest-only (IO) structure. An *inverse IO* (IIO) is an interest-only tranche whose coupon rate changes inversely with the index. It would be similar to an inverse floater that received no principal payments and had a multiple (coupon leverage) of 1.

In the previous example of a CMO backed by $100 in collateral paying a 5% coupon rate, one can distribute the annual cash flows from the collateral to a floater and an inverse IO in the manner shown in Table 16.4. There can be variations of this structure.

The floater will have a cap equal to the fixed rate of the collateral (5% in this example). An inverse IO will be sensitive to the shape of the yield curve. If short-term interest rates

[9] This assumes that the interest rate on the inverse floater could be zero, but not negative.
[10] The QM is assumed to be 40 bps in this example.

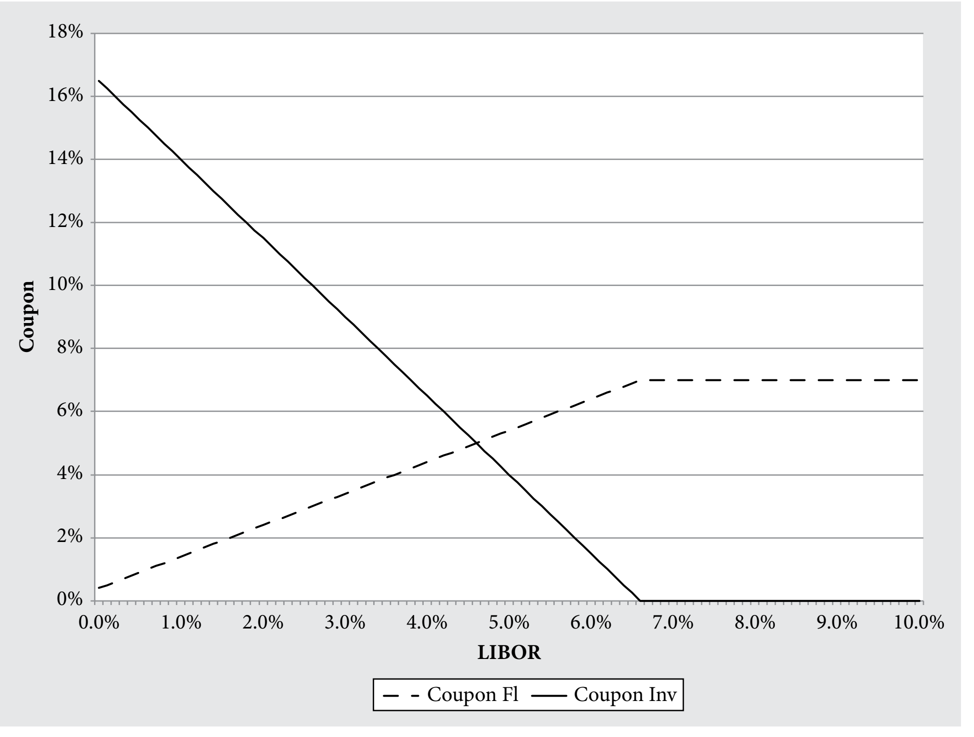

FIGURE 16.1 Coupon of floater and inverse floater with different levels of LIBOR

rise, an inverse IO will decline in value because of the reduced coupon. At the same time, as longer-term rates rise, an inverse IO will increase in value because of the slower prepayments, which increase the life of the inverse IO and the total future cash flows.

Another floating-rate CMO tranche type is a *superfloater*, which is a floating-rate tranche that pays a rate based on a multiple of the reference rate. For example, the coupon formula could be 2*LIBOR – 5%. Like other floaters, a superfloater would have a cap, and it would also have a floor to prevent the coupon rate from becoming negative.[11]

CDOs

Non-agency floaters also include floating-rate tranches of CDOs backed by mortgage collateral. CDOs backed by mortgage collateral were popular before the subprime crisis. Issuance of CDOs with structured finance collateral dropped dramatically in 2009 and only experienced modest recovery through 2014.[12]

[11] There could also be other tranche types, e.g., bonds with "toggle" interest, which are different from capped floaters in that, as the reference rate reaches a certain level, the coupon may drop instead of staying at a constant level.

[12] Global CDO issuance from file "sf-global-cdo-sifma.xls," available at <http://www.sifma.org/research/statistics.aspx>, accessed July 14, 2015.

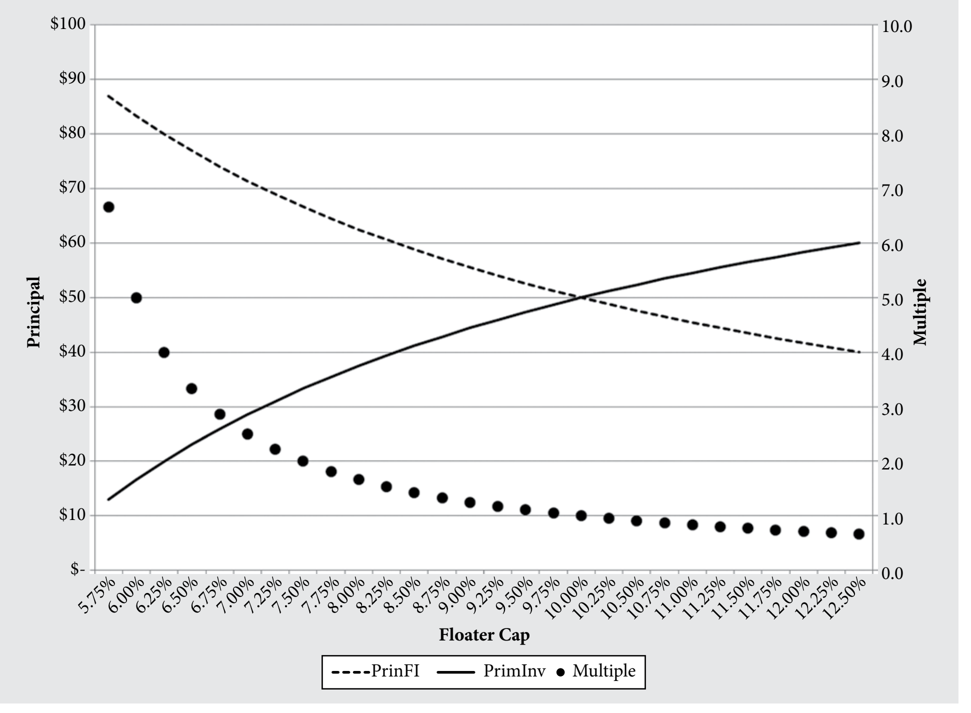

FIGURE 16.2 Multiple and relative principals of floater and inverse floater with different floater caps

Table 16.4 Hypothetical CMO structure using floater/inverse IO structure

Cash Flows	Collateral	Floater	Inverse IO
Principal	$100	$100	$0
Interest	$5	$100*(LIBOR+QM)	$100*(5% – LIBOR – QM)

Investment Characteristics of Floating-Rate Mortgage Securities

There are several reasons why investors may consider floaters backed by mortgage collateral. For instance, investors may view agency floaters as substitutes for money market instruments (e.g., Treasury bills where more frequent rollovers of matured securities would be required to maintain the exposure). Investors may also see floaters as an opportunity to earn the spread between the rate on the floater and the cost of financing by borrowing short-term in the repurchase (repo) markets.

In this section, we discuss key risks an investor bears when investing in floaters, namely, interest rate risk, spread risk, prepayment risk, credit risk, and liquidity risk.

Interest Rate Risk

As with any bond, the price of a mortgage security will fluctuate as interest rates change. Duration is a measure of the sensitivity of a bond's price to changes in interest rates (with a higher duration indicating higher price sensitivity). Specifically, duration measures the approximate percentage change in a bond's price for a 1% change in interest rates.

For a fixed-rate security, an increase in interest rates results in a decrease in the bond's price (all else equal), as its coupon rate moves further away from the prevailing market rate. A floating-rate security's price is generally less sensitive to changes in interest rates than that of a fixed-rate security, as the coupon rate for the floater is reset periodically using then-current market rates. Thus, floating-rate mortgage securities tend to have relatively low duration. That is, if the required margin (i.e., spread to the reference rate) stays constant, the value of the bond may not change much with changes in interest rates (all else equal). The potential for price fluctuations due to changes in interest rates increases with the length of time to the next reset date.

Floaters may be an attractive investment for investors who want to reduce the risk of price changes associated with changes in interest rates (for example, if an investor expects an increase in interest rates).

That being said, floating-rate mortgage securities (ARM passthroughs and CMOs) typically have caps on their coupon rates. As the coupon rate approaches the cap, the price of the floater will decline and the sensitivity of the floater's price to further changes in interest rates will increase.

Spread Risk

Spread risk is the exposure of a bond's price to the possibility of an increase in the difference ("spread") between the yield of the bond (e.g., a floater) and the yield of its benchmark (e.g., LIBOR). Spread risk can arise due to many underlying causes, including low market liquidity (see the section "Liquidity Risk"). To the extent that a bond is exposed to spread risk, its price will decline as market spreads widen. In contrast to interest rate risk, the price of a bond can decline even if benchmark interest rates do not change.

Prepayment Risk

Prepayments of mortgages within a pool collateralizing a mortgage security can affect the timing of principal repayments to bondholders. Prepayments within a mortgage pool are primarily the result of either sale of the property or refinancing of the loan. Because most residential mortgages in the US do not carry a prepayment penalty, the decision to refinance is driven largely by the level of prevailing interest rates. As mortgage rates decline, a homeowner may choose to refinance his existing mortgage with a lower-rate mortgage.

Prepayment risk refers to the possibility that, due to prepayments of mortgages in the underlying collateral pool, principal will be repaid to the mortgage security investor sooner than expected (also referred to as *contraction risk*). This typically happens in falling interest rate environments, as mortgages in the underlying collateral pool are refinanced. The risk is that the principal returned to the bondholder will have to be reinvested earlier than expected, and at lower market rates.[13]

For an investor in a floating-rate mortgage security, prepayment risk is mitigated. Coupon rates on the floating-rate mortgage security are reset periodically using then-current market rates, so the price of the bond generally changes little when interest rates change (assuming the required margin stays constant and the coupon rate does not approach the cap). If principal is repaid to the investor sooner than expected, that principal can be reinvested in another floating-rate security.

Structuring a CMO does not eliminate risks associated with the underlying collateral; rather, it redistributes those risks among the various tranches. Compared to the underlying fixed-rate collateral, a floater would have shorter duration and be less negatively convex. As a result, the inverse floater will be more sensitive to changes in interest rates and prepayment rates.

Credit Risk

Credit risk refers to the risk that contractually required principal and interest payments will not be paid when due and in full. For agency mortgage securities there is a government guarantee on required payments. As a result, these securities are viewed by the markets as having little (if any) credit risk.

Non-agency mortgage securities, on the other hand, typically incorporate credit enhancements to mitigate credit risk. Credit enhancements can be categorized as either internal or external. Internal credit enhancements are built into the structure of the security (e.g., senior/subordinated structure, overcollateralization, and/or reserve funds). External credit enhancements take the form of a third-party guarantee on the required payments (e.g., insurance or a letter of credit).

Liquidity Risk

There are a large number of dealers and investors in the mortgage securities markets. However, different types of securities may face different levels of liquidity risk due to the

[13] Conversely, extension risk connotes the possibility that principal will be repaid to investors later than expected. Here, the risk is that investors may find their funds tied up longer than expected, and miss the opportunity to earn a higher rate of interest on those funds.

markets in which they are traded and the characteristics inherent in the instruments themselves (e.g., complexity). As fewer market participants have expertise in a particular class of securities, that class may become less liquid. For example, an agency ARM passthrough may trade in a more liquid market than a CMO floater. This is because agency passthrough securities usually trade in a forward "to-be-announced" (TBA) market. In the highly liquid TBA market, agency passthrough securities trade in an unspecified market of homogenous securities. An academic study finds that the average round-trip cost for trading a TBA security is 4 bps in comparison to 97 bps for that of a CMO.[14]

Valuation and Analytics

The same approach is used to value both fixed-rate and floating-rate mortgage securities: projected cash flows (principal and interest payments) of a given security are discounted to determine a price.

For both fixed-rate and floating-rate mortgage securities, one needs to make assumptions about principal payments, which are affected by deal structure, prepayment rates, and credit risk/subordination.

To value floaters, one also needs to make assumptions regarding interest rates in order to project coupon payments. (Coupons on fixed-rate securities are also affected by interest rate assumptions as interest rates affect prepayments, but this is a less direct effect.) Therefore, there is added uncertainty of interest cash flows for floaters compared to fixed-rate securities.

CMO tranches, including floaters, are commonly valued using *Monte Carlo simulation*, where a large number of future interest rate and prepayment paths[15] are modeled (and also collateral defaults for non-agency CMOs) in order to estimate future cash flows on the underlying mortgage loans. These simulated collateral cash flows are distributed on a pro rata basis to agency ARM passthroughs. For CMOs, simulated collateral cash flows are distributed to the various tranches according to predetermined rules (and the CMO itself can be thought of as just a set of rules for distributing the collateral cash flows). Estimated future cash flows to the floater are then discounted to determine a present value for each potential path. The floater can then be valued by averaging the present values estimated across the various paths.

These types of valuation models provide the flexibility to account for a security's specific features as well as incorporate different assumptions regarding the future behavior

[14] Estimated over the period from May 16, 2011 to October 31, 2012. Nils Friewald, Rainer Jankowitsch, and Marti G. Subrahmanyam, "Transparency and Liquidity in the Structured Product Market," *Social Science Research Network* (October 15, 2014), 5. Available at <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2139310>, accessed July 14, 2015.

[15] An interest rate model is used to generate different scenarios for future interest rates, and a prepayment model is used to estimate prepayments corresponding to those future rates.

of interest rates and mortgage payments. At the same time, the models and assumptions used by market participants may differ, resulting in different valuations.

Factors affecting the pricing of floaters include:

- *QM*: The higher the QM, the higher the value of the floater, all else equal.
- *Level of the cap*: The cap represents an embedded option that the investor has effectively sold (i.e., is short). The value of a floater is the value of the floater without a cap minus the value of the cap. (Without a cap, the floater's value may not change much with changes in interest rates, all else equal.) The lower the level of the cap, the higher the likelihood of it being reached, resulting in a coupon payment which is lower than the prevailing interest rate. All else equal, the lower the level of the cap, the higher the value of the cap (and hence the lower the value of the floater).[16]
- *Current level of the reference rate*: The higher the current level of the reference rate, the higher the likelihood of the cap being reached. All else equal, the higher the current level of the reference rate, the higher the value of the cap (and hence the lower the value of the floater).
- *Interest rate volatility*: If interest rates are more volatile, then there is a higher likelihood of the cap being reached. All else equal, the higher the interest rate volatility, the higher the value of the cap (and hence the lower the value of the floater).
- *Prepayment speed*: Higher prepayments mean a shorter life for the floater. This lowers the value of the cap (and increases the value of the floater), all else equal.
- *Collateral defaults*: A change in expected collateral defaults can affect the valuation of non-agency CMOs.
- *Liquidity*: To the extent that the theoretical value of a floater differs from its observed market price, liquidity may be a factor.

Spread Measures

Two spread (margin) measures often used to evaluate floaters are option-adjusted spread and discount margin.

Option-Adjusted Spread

We have discussed how a Monte Carlo simulation can be used to estimate a floater's value. The *option-adjusted spread* (OAS) is the spread that, when added to each discount rate used to discount the expected future cash flows in such a model, makes the resultant valuation equal the security's market price. This spread measure takes into account the floater's embedded options (e.g., the prepayment option and the cap).

The OAS is the average expected spread over the benchmark yield curve. As the OAS increases (widens), the value of the floater declines, all else being equal. OAS can be used to identify "cheap" versus "expensive" securities. A security that gets a higher OAS from

[16] ARM passthroughs may also have additional optionality related to the periodic cap, e.g., tight periodic caps would reduce the value of an ARM passthrough, all else equal.

the model can be regarded as "cheap," or having higher expected yield. However, as the OAS is derived from a valuation model, and different market participants may have different models and assumptions, care must be taken in its interpretation.

Discount Margin

In practice, floaters are often quoted in terms of *discount margin* (DM). DM is the margin over a benchmark interest rate that, when used in discounting future cash flows of the floater, gives its current price.[17] When the floater is issued, its QM is usually selected so that the floater is priced at par—that is, DM is equal to QM at issuance. A discount bond will have a discount margin that exceeds the quoted margin, while a premium bond will have a discount margin that is less than the quoted margin.

The usual assumption in calculating DM is that the reference rate remains constant at its current level for the life of the security, and that the prepayment rate remains constant at an assumed level. These assumptions make the calculation of future cash flows straightforward. Because DM is easy to relate to price, it is convenient for quotation purposes. However, because of the simplifying assumptions embedded in its calculation, comparing DMs for floaters with different cap and prepayment assumptions may become problematic.

Illustration of Floater Prices Corresponding to Different DM and PSA Assumptions

Figure 16.3 and Figure 16.4 illustrate how an agency CMO floater with a coupon of 1-month LIBOR plus a 40 bps QM and a cap of 6.5% is affected by changes in DM and prepayment rates (as measured by PSA).[18] One can also see how the same price can correspond to different DM and prepayment assumptions. Note that when DM equals QM (40 bps in this case), the floater is priced at par, regardless of the prepayment assumption used (see Figure 16.4).

Duration Measures

As previously discussed, duration measures the sensitivity of a bond's price to changes in interest rates and spreads. We examine two duration measures relevant to floaters: index duration and spread duration.

[17] As an example of how to calculate a discount margin, consider a simple one-year $100 bond that has one annual interest payment upon maturity, determined as LIBOR [the benchmark] + 100 basis points [the quoted margin] (that is, LIBOR + 1%). Assume LIBOR is currently 5% and, for the calculation, will remain at this level over the course of the coming year. Assume further that all principal ($100) will be returned at maturity. The task is to find the rate of discount that, when applied to the future cash flow of this bond ($106, being principal of $100 plus interest of 6% for one year) equals the market price. That rate of discount is then described as LIBOR (5%) plus an additional amount (the discount margin), so that the same calculation and discount margin can be applied if LIBOR changes.

[18] PSA refers to the Public Securities Association Standard Prepayment Model. A higher PSA indicates a faster prepayment assumption.

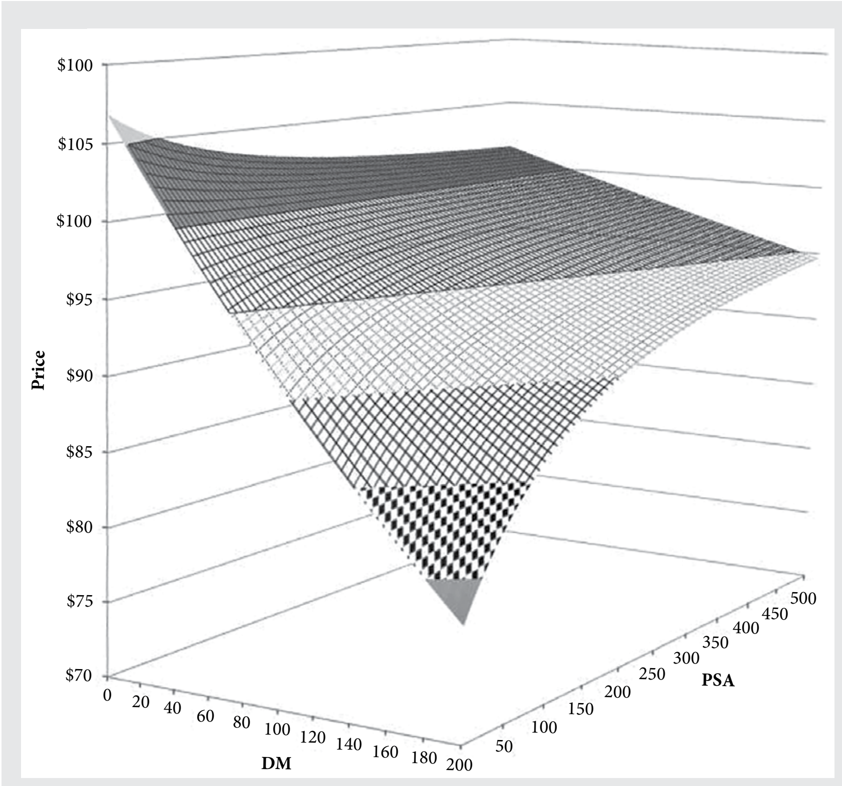

FIGURE 16.3 Combined Effect of DM and PSA on Floater Price

(Index) Duration

Index duration measures the sensitivity of a floater's price to changes in the reference rate (index). In the case of a floater, the sensitivity to changes in interest rates mostly comes from the cap. As interest rates get higher, the effect of the cap increases, with the floater eventually behaving more like a fixed-rate bond. If interest rates are farther away from the cap, e.g., in a low interest rate environment, then the duration of the floater is lower.

Figure 16.5 is an illustration of how a floater's index duration can change with different assumptions for 1-month LIBOR and prepayment rates (as measured by PSA). Note that when LIBOR is low the duration is also low. This is because the cap is so far away from the coupon rate that its effect is negligible. As LIBOR increases, so does the duration. The duration also declines with faster prepayments as the expected life of the bond decreases.[19]

[19] Duration is also affected by the LIBOR volatility assumption. The higher the volatility is, the larger the effect of the cap on valuation. If interest rates had zero volatility (i.e., remained constant at a given level), then the floater would become a fixed-rate bond that paid the lower of (a) the reference rate + QM, and (b) the cap rate.

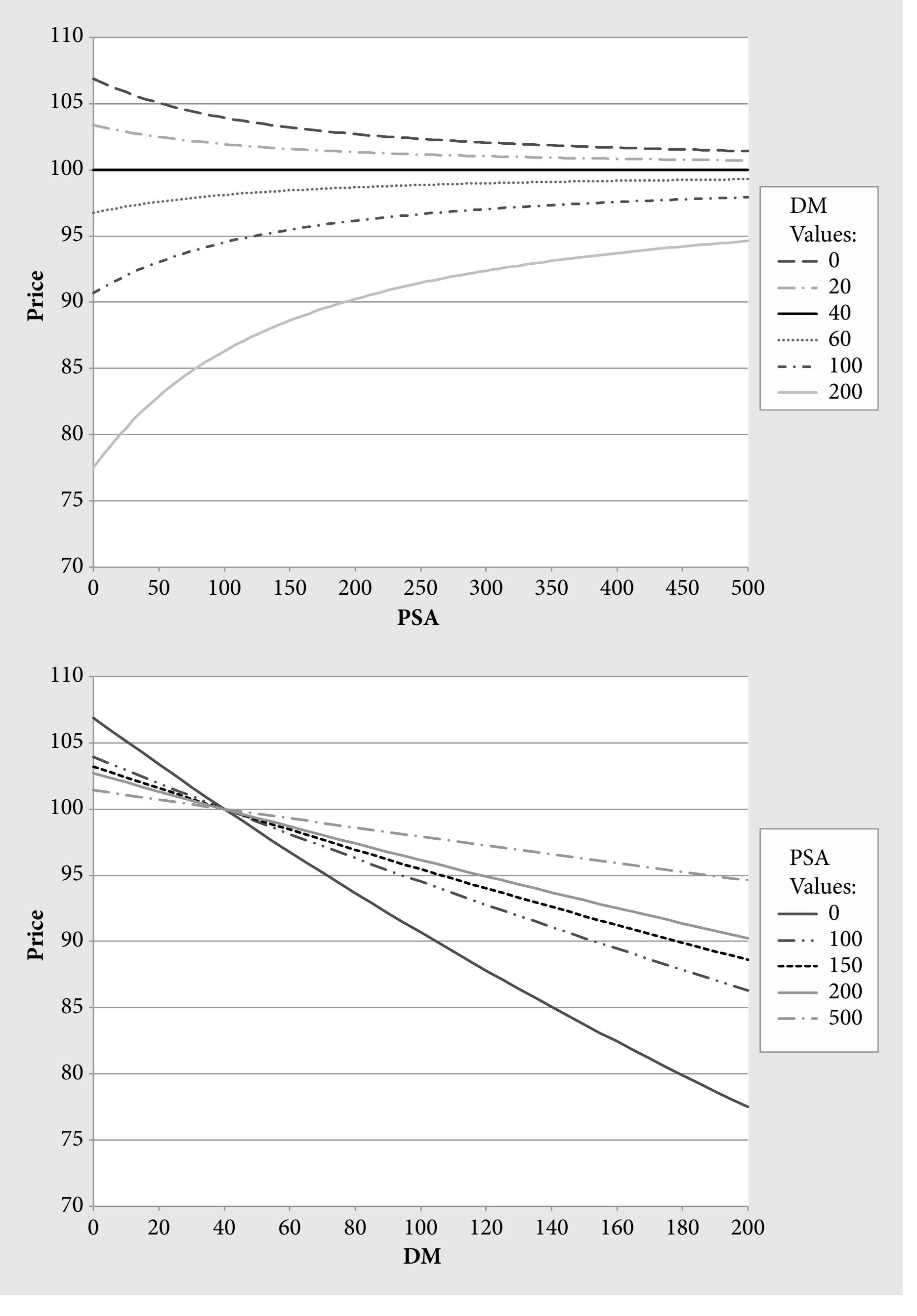

FIGURE 16.4 Individual Effects of DM and PSA on Floater Price

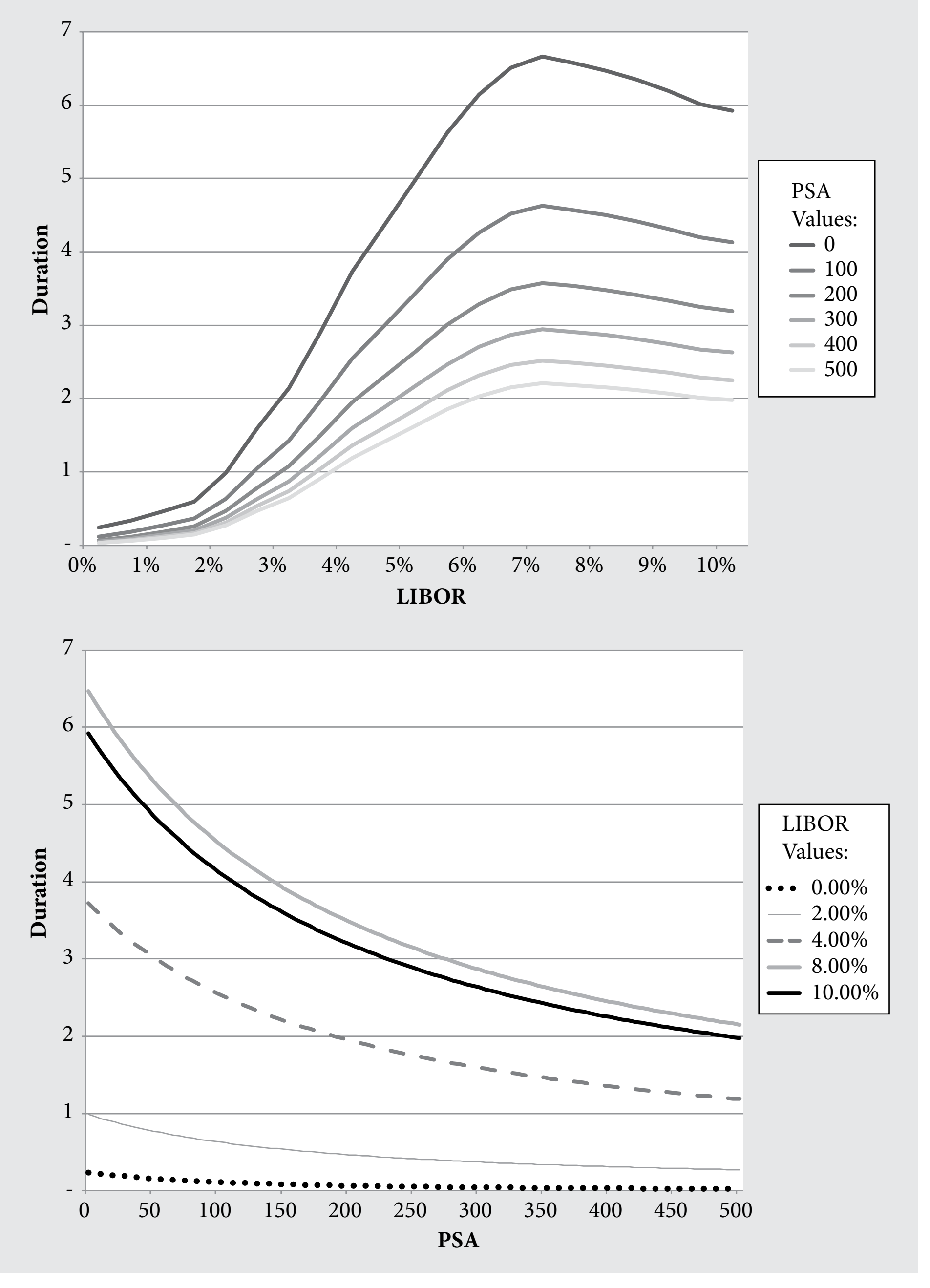

FIGURE 16.5 Index duration for different levels of LIBOR and PSA

Spread Duration

A different measure of price sensitivity is *spread duration* (SD). Spread duration is used to estimate the percentage increase (decrease) in the price of a security for a one percentage point decrease (increase) in market spreads. For example, spread duration of four means that if the spread over benchmark increases by 1% then the price of the bond will decrease by (approximately) 4%. If, for example, two otherwise similar floaters with SD of four have quoted margins of 40 bps and 60 bps, then the difference in prices will be approximately the difference in the quoted margins times the spread duration, i.e., 20 bps * 4 = 0.8%.

Figure 16.6 shows how the floater spread duration changes with different assumptions for DM and prepayment rates (as measured by PSA). Note that SD declines (together with the expected life of the floater) as prepayments accelerate (i.e., as the assumed PSA increases).

Spread duration can also be calculated using the change in price of a floater for two different OAS levels (referred to as "option-adjusted duration"). If one first calculates OAS from price, and then shifts the benchmark curve and recalculates price using the new OAS, one gets the price reaction to the shift in the interest rates.

Convexity

MBS generally have *negative convexity*, such that as interest rates decrease, duration of the bond decreases. Generally, CMO floaters have lower duration and lower negative

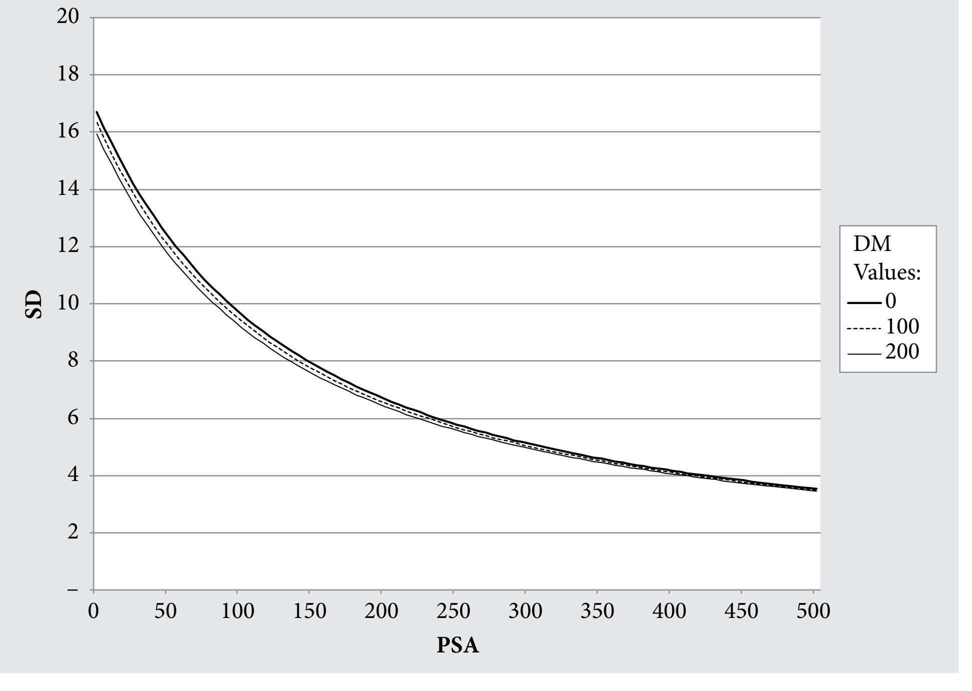

FIGURE 16.6 Floater spread duration for different DM and PSA

convexity than their underlying fixed-rate collateral. Most of the duration and negative convexity is absorbed by the corresponding inverse floater.

However, some negative convexity comes from the cap. This effect is similar to how the cap adds interest rate sensitivity (defined earlier as duration). As the coupon rate starts to approach the cap, the value of the floater declines (and its duration increases). Without a cap, floaters would have little duration or convexity.

Market Overview

This section provides a summary of issuances of agency ARM passthrough securities and CMO floaters over time. Here our focus is on the US mortgage sector.

Historical Issuance of Agency ARM Passthrough Securities

Figure 16.7 shows the historical issuance of agency ARM passthrough securities, as well as the total issuance of agency mortgage passthroughs. In 2014, issuance of agency ARM passthroughs totaled $42.4 billion and represented approximately 5% of the total issuance of agency mortgage passthroughs.

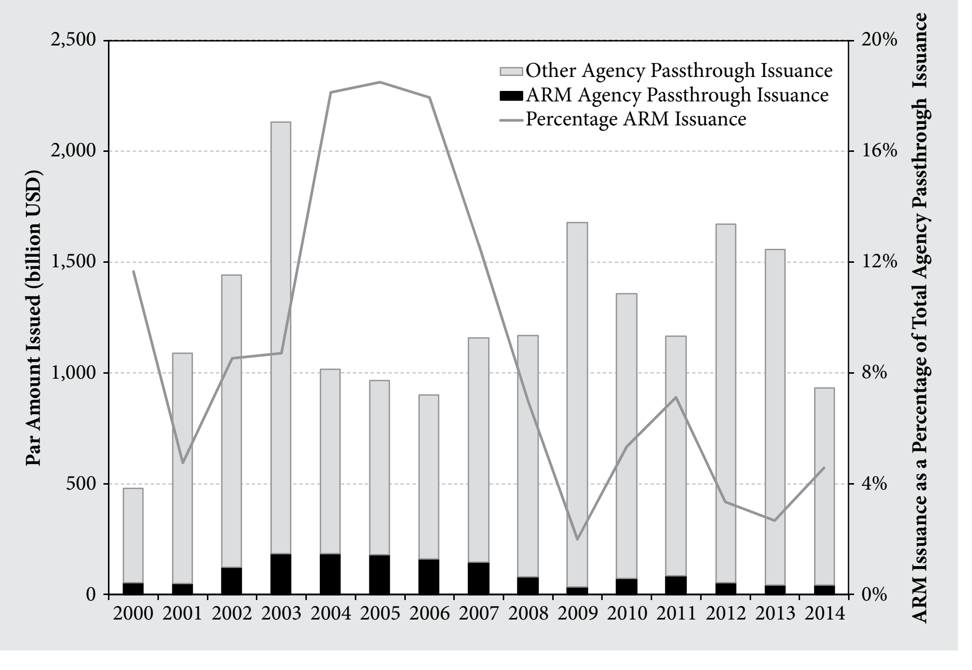

FIGURE 16.7 Agency passthrough issuance by collateral type, 2000–14

Source: Data from *Inside Mortgage Finance*

The percentage of mortgage passthrough securitization collateralized by adjustable-rate mortgage loans has fluctuated over time. This percentage was approximately 18% in 2004–6, declined to 13% in 2007, and remained at 7% or below in 2008–14. The pattern broadly mirrors the trend of origination of adjustable-rate mortgages as a percentage of total mortgage origination.

Some of the decline in adjustable-rate mortgage origination may be explained by the drop in interest rates and borrowers' views of relative borrowing costs for fixed-rate versus adjustable-rate mortgages.[20] Additionally, because of the decline in housing prices and a higher loan limit for conforming mortgages, a larger proportion of post-2008 originations have been conforming mortgages (relative to origination activity in 2004–7). This change likely also contributed to the decline in adjustable-rate mortgage origination.

Historical Issuance of CMO Floaters

Floaters are a substantial portion of the CMO market. In 2014, more than $50 billion of CMO floaters were issued (including both agency and non-agency CMO floaters). Issuance of CMO floaters was higher (and represented a larger proportion of total CMO issuance) in the years 2005–7 than in the years 2008–14. This was likely driven by the high percentage of non-agency CMOs issued in 2005–7. In fact, during this period, more than half of total CMO issuance was non-agency. However, the percentage of non-agency CMO issuance declined to less than 30% in 2008, and remained at less than 20% in 2009–14.[21]

Snapshot of CMO Floater Issuances and their Salient Features

In this section, we review various features of CMO floaters issued in the US in the first quarter of 2015.

Issuers

Of the more than 500 CMO floaters issued with a total par amount of more than $20 billion, agency issuances represented approximately 40% of the total par amount issued.

An additional category of floaters (representing approximately 20% of the total par amount issued) were credit-risk-sharing securities issued by the agencies. These are securities that transfer some of the retained credit risk on mortgage pools from the

[20] Emanuel Moench, James Vickery, and Diego Aragon, "Why Is the Market Share of Adjustable-Rate Mortgages So Low?" *Current Issues in Economics and Finance* 16/8, Federal Reserve Bank of New York (December 2010), 1–11.

[21] Data from *Inside Mortgage Finance*.

agency to investors.[22] While these securities are issued by the agencies, they also have similarities with non-agency issuances (e.g., the fact that the investor bears credit risk). For the purposes of this chapter, we consider these credit-risk-sharing securities to be non-agency issuances.

The remaining floaters (representing approximately 40% of the total par amount of floaters issued) were other non-agency issuances. The top three non-agency issuers of floaters (by par amount issued) were J.P. Morgan Mortgage Trust, Nomura Resecuritization Trust, and Bank of America Funding Corporation.

Reference Rates

The most popular reference rate used for the CMO floaters was 1-month USD LIBOR. This reference rate was used for all of the agency issuances and for the vast majority of the non-agency issuances. Other reference rates used for non-agency issuances included 12-month USD LIBOR and the 12-month Treasury Average.

Quoted Margins

The CMO floaters with a 1-month USD LIBOR reset index had a median quoted margin of around 35 bps. Almost 80% of these floaters had an initial quoted margin between zero and 50 basis points.

More than half of the non-agency floaters had a stepped spread, with the quoted margin increasing during the term of the security. None of the agency floaters analyzed had a stepped spread.

Caps

For the deals with a 1-month USD LIBOR reset index and with caps reported, most caps were between 5% and 7%. The non-agency deals with caps reported tended to have higher caps than the agency deals. Some of the agency floaters and the majority of the non-agency floaters have no caps reported. However, deals without an explicit floater cap may instead incorporate an available funds cap. This serves to limit the coupon rate paid on the floater, ensuring the interest paid by the collateral is sufficient to pay the floater tranche.

Trading in CMO Floaters

Floaters may be purchased by investors who do not plan to hold to maturity and hence do not wish to bear the risk of having the value of a bond depreciate due to changes in interest rates. Figure 16.8 shows the average daily trading volume of floaters as a percentage

[22] The agency bears this credit risk due to the fact that it has guaranteed payments on mortgage-backed securities backed by those mortgage pools. Investors in credit risk sharing securities may not receive a full repayment of principal, depending upon the performance of the underlying mortgage pools.

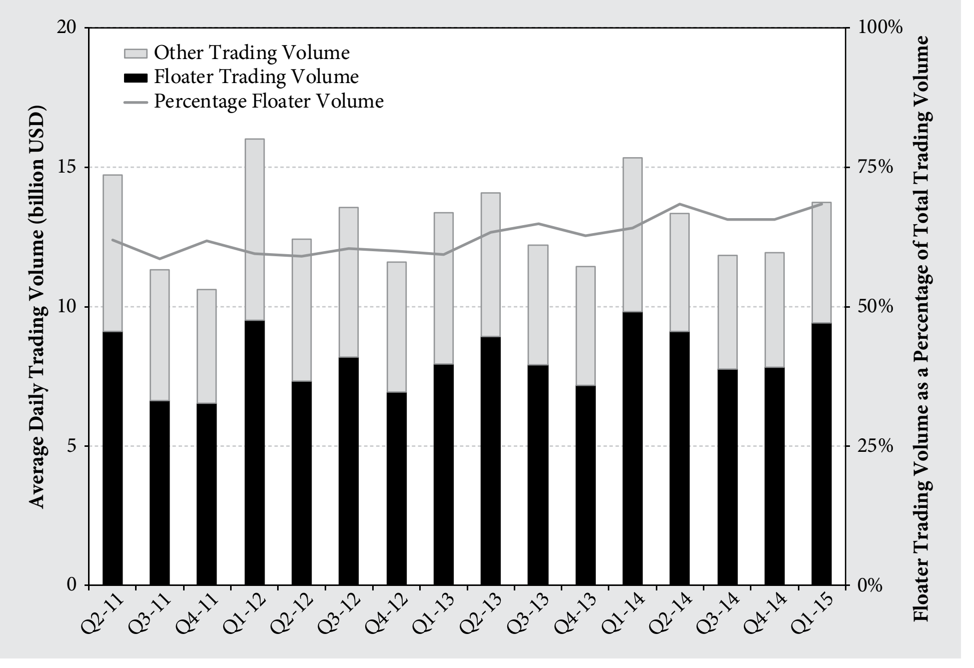

FIGURE 16.8 Percentage floater average daily trading volume (of total CMO volume), Q2 2011–Q1 2015

Source: US average daily trading volume data from file "sf-us-sf-trading-volume-sifma.xls," available at <http://www.sifma.org/research/statistics.aspx>, accessed July 14, 2015

of total CMO daily trading volume for Q2 2011 to Q1 2015 (the only quarters for which data were available).

CMO floaters (both agency and non-agency) have represented between 55% and 70% of CMO trading volume from Q2 2011 to Q1 2015.

Key Points

- Floating-rate mortgage securities come in the form of agency ARM passthroughs, agency CMOs, and non-agency CMOs.
- The coupon rate on the floater is reset periodically and typically has a cap and a floor.
- Agency ARM passthrough securities get their floating-rate feature from the underlying adjustable-rate mortgages.
- CMO floaters can be created from fixed-rate collateral using some form of a floater/inverse floater structure.
- Non-agency CMO floaters can also be created using an interest rate swap.
- The level of the cap largely determines the structure of a CMO floater.
- Floaters have lower interest rate risk and prepayment risk than fixed-rate mortgage securities.
- Investors may view floaters as higher yielding substitutes for short-term money market instruments.

- As with other mortgage securities, when valuing floaters, one needs to make assumptions regarding the future behavior of interest rates, prepayments, and, in the case of non-agencies, losses on the underlying collateral.
- Common tools in analyzing floaters are discount margin, option-adjusted spread, index duration, and spread duration.
- In the years 2008–14, ARM passthroughs and CMO floaters represented a smaller proportion of total passthrough and CMO issuance, respectively, than they had in 2005–7.

Acknowledgment

We would like to thank Ashley Levesanos and Marcin Pruski for their excellent research assistance.

CHAPTER 17

INVERSE FLOATING-RATE CMOs

CYRUS MOHEBBI, RAYMOND YU, MARC BARAKAT, AND PAULA STEISEL GOLDFARB

After reading this chapter you will understand:

- how inverse floating-rate CMOs are carved out from the cash flow of a collateral pool;
- the structural features of inverse floating-rate CMOs, such as coupon cap, multiplier, and index;
- the price sensitivity of inverse floating-rate CMOs to changes in the yield curve and changes in prepayments (namely, the LIBOR and prepayment effects);
- the reasons for including inverse floating-rate CMOs in an investment strategy.

Inverse floating-rate securities are leveraged securities that offer investors a floating-rate coupon that periodically resets off an index, usually 1-month LIBOR. In contrast to floating-rate collateralized mortgage obligations (CMOs), the coupon on an inverse floater changes by a specified multiple of the change in the index, decreasing when the index rises and increasing when the index falls. This unusual feature makes inverse floaters unique among mortgage securities. This chapter discusses the structure and investment characteristics of these securities.

Structural Features

The investment characteristics of an inverse floater are determined by the nature of the underlying collateral and the structural features associated with the bond (including its multiplier, coupon cap, and index). The impact of the collateral type is primarily prepayment-related and is discussed in the next section. Structural features, however, are key to understanding how the coupon on the bond will respond to interest rates changes.

In typical real estate mortgage investment conduit (REMIC) structures, the cash flows associated with an inverse floater and the corresponding floater each represent a divided interest in the cash flows of a fixed-rate bond. Thus an inverse floater and floater combination can be structured by carving up the cash flows of what would otherwise be a fixed-rate planned amortization class (PAC), companion, sequential, or *pro rata* collateral strip class.

An example of an inverse floater and floater structure can be shown by dividing a fixed-rate cash flow into different components. We can start by taking $100 million 3.5% coupon fixed-rate collateral and dividing into two *pro rata* components as shown in Figure 17.1: $50 million with 7% coupon and $50 million with 0% coupon (or PO).

The $50 million 7% coupon class can be structured into a $50 million 7% cap floating-rate security (floater) and a $50 million notional inverse interest-only (IIO) security with the coupon interest allocated as follows: holders of the floater receive a coupon of 1-month LIBOR + 50 basis points (bps) with a cap of 7%, whereas the holders of the IIO receive a coupon given by the formula: 6.50 – 1-month LIBOR (see Figure 17.2).

The floater and the IIO combine to 7% fixed coupon. The inverse floater is created by combining the PO (Component 2) with the IIO (Component 1B). If $50 million PO is combined with $50 million IIO, the inverse floater would have a multiplier of 1 with an initial coupon derived from the formula 6.50 – 1-month LIBOR. If 1-month LIBOR is 1%, the $50 million inverse floater would have a coupon of 5.50% and the $50 million floater would have a coupon of 1.50%. See Figure 17.3.

By combining the $50 million IIO with a different amount of the PO, a more highly levered inverse floater can be structured. For example, if $50 million IIO is combined with only $25 million PO, the inverse floater would have a multiplier of 2 with a coupon cap of 13%, thus the ratio of IIO to PO determines the leverage and coupon of the inverse floater. See Table 17.1.

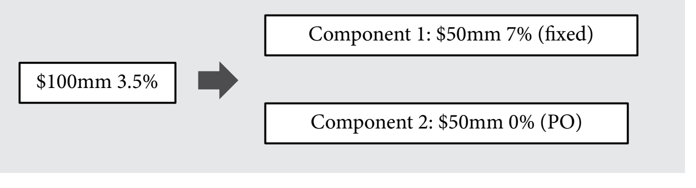

FIGURE 17.1 Floater/inverse-floater structure

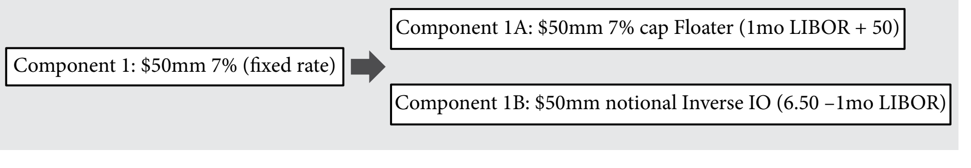

FIGURE 17.2 Floater/IIO structure

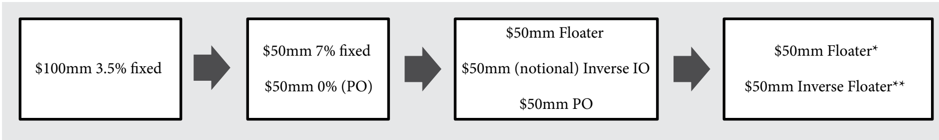

FIGURE 17.3 Floater/inverse-floater structure

Note: *$50 million floater, 1.5% coupon (formula: 7 cap, 1-month LIBOR + 50bps)
**$50 million inverse floater, 5.5% coupon (formula: 6.5 – 1-month LIBOR)

Table 17.1 Multiplier chart

Floater	IIO	PO	Multiplier	Inverse Floater	Inverse Floater Formula	Cap
$50mm	50mm	50mm	1	50mm	6.5 – (1 × 1mo LIBOR)	6.50
$50mm	50mm	25mm	2	25mm	13.0 – (2 × 1mo LIBOR)	13.00
$50mm	50mm	10mm	5	10mm	32.5 – (5 × 1mo LIBOR)	32.50
$50mm	50mm	5mm	10	5mm	65.0 – (10 × 1mo LIBOR)	65.00

Table 17.2 Coupon chart

Bond 4: Inverse Floater Formula 65.0—(10 × 1month LIBOR)	
LIBOR	Coupon
1.00	55.00
2.00	45.00
4.00	25.00
6.00	5.00
7.15	0.00

The multiplier of the inverse floater determines the leverage of the coupon. In Table 17.1, the first bond has a multiplier of 1 and is thus not levered. The fourth bond has a multiplier of 10 and has high leverage (see Table 17.2).

Investment Characteristics

The price behavior of an inverse floater in different interest rate environments is affected by changes in both the coupon, which is tied to a specific part of the yield curve, and in prepayments, which (for fixed-rate collateral) depend on long-term mortgage rates and the long end of the Treasury curve. In addition, the price sensitivity of an inverse floater to changes in prepayments is heavily influenced by how the bond is structured. Inverse floaters that reset off short-term rates, such as 1-month LIBOR, are thus dependent on both the short end of the yield curve (coupon sensitivity) and the long end of the yield curve (prepayment sensitivity).

To illustrate the price behavior of inverse floaters in different interest rate environments,[1] let us consider two types of yield curve shifts:

- **Type 1—"The LIBOR Effect":** A steepening or flattening of the Treasury curve with the movement occurring in the short and intermediate part of the curve (i.e., long-term rate unchanged). Price movements in this scenario isolate the sensitivity of the inverse floater to changes in short- and intermediate-term rates.
- **Type 2—"The Prepayment Effect":** A similar steepening or flattening of the Treasury curve with the movement occurring primarily in the long end of the yield curve (i.e., short-term rates unchanged). In this scenario, the bond's price sensitivity to long-term rates is shown.

Table 17.3 illustrates the price sensitivity of a 1-month LIBOR inverse-floater *pro rata* strip bond (FHS 311 V12) backed by FHLMC 3.5 collateral with a multiple of 0.875× and another 1-month LIBOR inverse-floater *pro rata* strip bond (GNR 06-28 VS) backed by GNMA 6.5 collateral with a multiple of 13. Prices are calculated under the simplified assumption that both bonds trade at a constant yield: 7% for FHS 311 V12 and 10% for GNR 06-28 VS. Variations in prepayments for both bonds will be small, since under the Type I scenario long-term mortgage rates are held constant across the scenarios considered.

Table 17.3 Type 1—"The LIBOR Effect"

Scenario	Base Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
LIBOR (bps)	0.16	+100	+200	+300	+400	+500
10YR	2.20	unch	unch	unch	unch	unch
GNR 06-28 VS (13 × levered) @ 345-00, total rate of return (TRR), 1-year horizon, priced to constant yield						
TRR	9.7%	(3.2%)	(16.9%)	(31.9%)	(48.3%)	(66.8%)
Horizon Price	345-00	303-00	261-00	219-00	177-00	135-00
CPR	15	15	15	15	15	15
FHS 311 V12 (0.875× levered) @ 95-00, total rate of return (TRR), 1-year horizon, priced to constant yield						
TRR	6.4%	1.0%	(4.6%)	(9.3%)	(15.2%)	(21.3%)
Horizon Price	95-00	90-00	85-00	81-00	76-00	71-00
CPR	8	8	8	8	8	8

[1] The interest rate scenarios and returns presented in the chapter are pro forma in nature, for academic and discussion purposes only, and should in no way be used as the basis for any investment activity or decision.

For FHS 311 V12, the coupon of the bond has a formula of 6.16875 – (0.875 × 1-month LIBOR). The coupon varies in Table 17.3 from 6.02875% (for the base case scenario with 1m LIBOR at 0.16) to 1.79375% (for a 500 bp upward shift in LIBOR). For GNR 06-28 VS, the coupon of the bond has a formula of 87.1– (13 × 1-month LIBOR). As can be seen in Table 17.3, the coupon varies from 85.02% (for the base case scenario) to 22.10 (for a 500 bp upward shift in LIBOR). Given the greater variation in coupon for GNR 06-28 VS since it has a higher multiple of 13, one would expect more price variation in this bond than in FHS 311 V12 across the interest rate scenarios shown and this is indeed the case. Both bonds are affected by the shift in short-term interest rates, but FHS 311 V12 has much less price variability because the coupon changes much less than the high multiple GNR 06-28 VS.

Table 17.4 illustrates the price sensitivity of GNR 06-28 VS compared to a different inverse floater, FHR 4102 CS, a deep discount inverse floater backed by FHLMC 3% collateral across several Type II interest rate scenarios (long-term rates vary while short-term rates remain unchanged). Prices are again calculated under the simplified constant yield assumption of 10% for GNR 06-28 VS and 6.5% for FHR 4102 CS. Variation in prepayments for the collateral underlying both bonds is largely dependent on changes in mortgage rates, which range from 3% (a 100 bp downward shift in the 10-year Treasury) to 6.5% (a 250 bp upward shift in the 10-year Treasury yield).

For GNR 06-26 VS, the coupon is 85.02% in each scenario as short-term rates (including 1-month LIBOR) are unchanged across all interest rate scenarios shown. With the current mortgage rate today around 4.0%, the GNSF 6.5% collateral backing GNR 06-26 VS is less sensitive to long-term interest rates falling and rising since it is seasoned and deep in the money. We assume prepayments increase and decrease 2 conditional prepayment

Table 17.4 Type 2—"The Prepayment Effect"

Scenario	Base Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7
LIBOR	0.16	unch	unch	unch	unch	unch	unch	unch
10YR (bps)	2.20	−100	−50	+50	+100	+150	+200	+250
GNR 06-28 VS (stable seasoned GN 6.5 collateral) @ 345-00, total rate of return (TRR), 1-year horizon, priced to constant yield								
TRR	9.7%	(0.2%)	4.6%	15.5%	21.9%	28.9%	36.4%	44.9%
Horizon Price	345-00	313-00	329-00	364-00	385-00	409-00	435-00	466-00
CPR	15	19	17	13	11	9	7	5
FHR 4102 CS (newer, larger loan size, FHLMC 3.0 collateral) @ 73-00, total rate of return (TRR), 1-year horizon, priced to constant yield*								
TRR	5.5%	35.9%	26.7%	2.8%	0%	(2.7%)	(5.5%)	(8.3%)
Horizon Price	73-00	97-00	88-00	71-00	69-00	67-00	65-00	63-00
CPR	4	20	12	3	2	2	2	2

Note: *Scenario 4 through 7 constant yield pricing was slightly modified.

rates (CPR) for every 50 bp move in 10-year Treasury yields (decrease when yields rise and increase when yields decline). FHR 4102 CS is backed by new weighted-average loan age (WALA) FHLMC 3 which is out-of-the-money collateral. The borrowers have no incentive to refinance in the base case since their mortgage rate is below the current market rate. However once the mortgage rate declines below the loan rate, prepayments tend to accelerate with this collateral. Since this bond is currently at a deep discount, the price sensitivity is greater as rates fall, since this bond is more prepayment-sensitive. We assume the bond can only slow down marginally, but can prepay 8 CPR faster for every 50 bp decline in 10-year Treasury yields. In the base case scenario, the bond is a 14-year average life, but in scenario 1 (−100 bps), the bond shortens to a 1-year average life and exhibits great price appreciation. In rising-rate scenarios, since the bond extends in average life, the bond price declines as would be expected for a positive duration security.

To further illustrate the price sensitivity of inverse floaters, we combine different assumptions from the Type 1 (the LIBOR Effect) and the Type 2 (the Prepayment Effect) yield curve shifts. In the declining-rate scenarios (Scenario 1 and Scenario 2), we assume only long-term rates decline which will impact prepayments. In the rising-rate scenarios (Scenarios 3 through 7), we assume both short-term and long-term rates rise (1-month LIBOR increases and prepayments slow). We compare the three inverse floaters previously discussed in Table 17.5.

Table 17.5 LIBOR and prepayment effects

Scenario	Base Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7
LIBOR	0.16	unch	unch	+50	+100	+150	+200	+250
10YR (bps)	2.20	−100	−50	+50	+100	+150	+200	+250
GNR 06-28 VS (seasoned premium inverse floater) @ 345-00, total rate of return (TRR), 1-year horizon, priced to constant yield								
TRR	9.7%	(0.5%)	4.6%	8.8%	7.6%	5.8%	3.3%	(5.7%)
Horizon Price	345-00	313-00	329-00	341-00	336-00	329-00	320-00	292-00
CPR	15	19	17	13	11	9	7	7
FHS 311 V12 (current coupon 3.5% inverse floater) @ 95-00, total rate of return (TRR), 1-year horizon, priced to constant yield								
TRR	6.4%	8.2%	7.3%	3.2%	(0.1%)	(4.6%)	(9.2%)	(12.8%)
Horizon Price	95-00	97-00	96-00	92-00	89-00	85-00	81-00	78-00
CPR	8	22	14	7	6	5	4	4
FHR 4102 CS (deep discount inverse floater, FHLMC 3.0 collateral) @ 73-00, total rate of return (TRR), 1-year horizon, priced to constant yield								
TRR	5.5%	35.9%	26.7%	(0.3%)	(7.7%)	(13.9%)	(18.9%)	(25.5%)
Horizon Price	73-00	97-00	88-00	69-00	64-00	60-00	57-00	53-00
CPR	4	20	12	3	2	2	2	2

Reasons for Including Inverse Floaters in an Investment Strategy

The preceding discussion illustrates some of the important characteristics of inverse floaters and suggests several reasons for considering the addition of inverse floaters to an investment portfolio:

- **Yield Enhancement:** Inverse floaters usually offer much higher yields than other less volatile MBS in order to compensate investors for the added risks associated with these securities. The addition of a small inverse-floater component can thus be used to boost the current yield of a mortgage portfolio. Fund managers may be willing to assume the additional price risk of the inverse floater if they feel the potential yield pickup is sufficient compensation for this risk.
- **Interest Rate View:** Inverse floaters afford the investor, who has a firm opinion on the direction of interest rates, an opportunity to make a leveraged investment based on that opinion. For example, an investor who believes long-term interest rates may decrease, while short-term rates will remain stable or only rise slightly, may wish to consider the purchase of a deep-discount low-multiplier inverse floater that would benefit from an increase in prepayments. An investor with almost the opposite view on longer-term interest rates (one who believes that long-term rates may rise while short-term rates will continue to decline) should consider a high multiple LIBOR-based premium inverse floater, which benefits more from slower prepayments similar to an IO, but a coupon that increases as LIBOR and other short-term rates decrease. The holder would benefit both from the decline in prepayments as long-term rates rise and from a high coupon should short-term rates fall further or remain stable. Alternatively, if an investor has the opinion that both long-term and short-term rates may increase, an inverse floater may be less suitable if the bond extends in duration and loses coupon from an increase in the short-term index.
- **Floating-Rate Portfolio Hedge:** An inverse floater whose coupon is tied to a short-term rate, such as 1-month LIBOR, may be used to partially hedge the interest rate risk of a portfolio of LIBOR floaters. In particular, the addition of inverse floaters to such a portfolio might be used to lengthen duration and, at the same time, lower the sensitivity of the portfolio to changes in short-term rates. This would be an appropriate strategy if the portfolio manager wished to better position the portfolio for an anticipated decline in both long-term and short-term rates.

Key Points

- Inverse floating-rate CMOs are carved out of a collateral pool in three steps: (1) splitting the cash flow into a principal-only (PO) bond and a fixed bond; (2) from that fixed bond creating a floating-rate bond and an inverse-floating-rate interest-only (IIO) bond, and (3) by combining the PO bond with the IIO bond.

- Inverse floating-rate CMOs are subject to coupon caps which determine the maximum coupon that these securities can pay.
- Inverse floating-rate CMOs can be leveraged by combining a smaller amount of the PO bond with the IIO bond.
- The ratio of the amount of IIO over the amount of PO is called the multiplier.
- Inverse floating-rate CMOs are sensitive short-term interest rates that directly impact their coupon; the higher their multiplier the higher this sensitivity.
- Inverse floating-rate CMOs are sensitive long-term interest rates through the impact of those rates on prepayment speeds.
- Reasons to invest in inverse floating-rate CMOs include yield enhancement, a view on interest rates, and hedging a floating-rate exposure.

CHAPTER 18

STRIPPED MORTGAGE-BACKED SECURITIES

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PAULA STEISEL GOLDFARB

AFTER reading this chapter you will understand:

- the different types of stripped mortgage-backed securities and how they started;
- the investment characteristics that govern SMBS;
- who invests in SMBS and why;
- the sensitivity of different types of SMBS to changes in interest rates and prepayment rates;
- the pricing of different types of SMBS.

In 1983 Freddie Mac (FHLMC) launched the collateralized mortgage obligation (CMO) structure that enabled issuers to tailor-make mortgage securities according to investor coupon, maturity, and prepayment risk specifications. In July 1986, Fannie Mae (FNMA) introduced a new addition to the mortgage security product line—*stripped mortgage-backed securities* (SMBS). By redistributing all or portions of the interest and/or principal cash flows from a pool of mortgage loans to two or more SMBS classes, FNMA developed a new class of mortgage securities that enabled investors to take strong market positions on expected movements in prepayment and interest rates. As the mortgage passthrough market has matured, the number of derivative products available has increased to give investors a broad range of choices to help them achieve their investment goals. In addition to straight *interest-only* (IO) securities and *principal-only* (PO) securities, investors may now choose from a wide array of synthetic coupons from each strip issue. Investors are able to fine-tune their derivatives to match their desired sensitivity to interest rate, prepayment, and market risk.

SMBS are highly sensitive to changes in interest rate and prepayment speeds and tend to display asymmetric returns. SMBS certificates that are allocated all or large proportions of underlying principal cash flows tend to display very attractive *bullish* return profiles. As market rates drop and prepayments on the underlying collateral increase, the return of these SMBS will be greatly enhanced since principal cash flows will be returned earlier than expected. Conversely, SMBS that are entitled to all or a large percentage of the interest cash flows have very appealing *bearish* return characteristics since greater amounts of interest cash flows are generated when prepayments of principal decrease (typically when market rates increase).

Overview of the SMBS Market

The SMBS market has grown substantially since the introduction of the first SMBS in July 1986. In total, over $500 billion agency SMBS in over 700 issues have come to market as of December 2014, as shown in Figure 18.1. In addition to Trust IO and POs—the most common form of SMBS—there are billions of structured IO and POs within collateralized mortgage obligation (CMO) deals (described below). In 2010, Markit introduced the IOS Index which has become another popular source for IO and PO exposure.

Types of SMBS

Strip securities exist in various forms. The first and earliest type of mortgage strip securities were called *synthetic-coupon passthrough securities*. Synthetic-coupon passthroughs receive fixed proportions of the principal and interest cash flow from a pool of underlying mortgage loans. Synthetic-coupon passthroughs were introduced by FNMA in mid-1986 through its "alphabet" strip program.

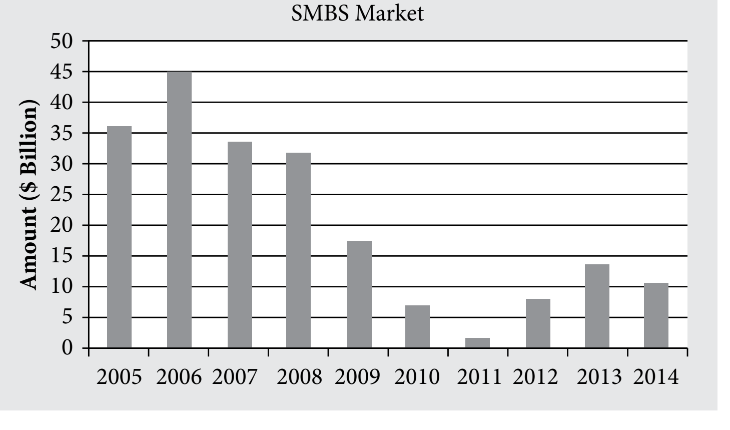

FIGURE 18.1 SMBS issuances per year

Trust IOs and Trust POs, the second and most common type of strip securities, were introduced by FNMA in January 1987. IOs and POs receive, respectively, only the interest or only the principal cash flow from the underlying mortgage collateral. FNMA and FHLMC Trust IO/PO SMBS represent the major issuance and trading activities in the SMBS market. A liquid and dynamic secondary market in conjunction with the agency to-be-announced (TBA) market has been established to allow quick and frequent transactions. Benchmark bonds in the sector (large in size and most liquid issues) enhanced liquidity and investor pricing transparency.

A third type of strip security, the *CMO strips* (also called structured IOs and POs) are also popular among issuers and investors. As implied by their name, structured IOs and POs are tranches within a CMO issue that receive only principal or interest cash flows or have synthetically high coupon rates.

Development of the SMBS Market

In this section we provide the historical development of the SMBS market.

The First Mortgage Strip—FNMA SMBS "Alphabet" Strip Securities

FNMA pioneered the first stripped mortgage security in July 1986 through its newly created SMBS Program. For each issue of SMBS Series A through L, FNMA pooled existing FHA/VA and GPM mortgage loans that had been held in its portfolio and issued two SMBS passthrough certificates representing ownership interest in proportions of the interest and principal cash flows from the underlying mortgage loan pools. Alphabet strips were subsequently called synthetic discount- and premium-coupon securities, since the coupon rate of the alphabet strip was quoted as the percentage of the total principal balance of the issue.[1] In total, 12 alphabet strip deals were issued by FNMA in 1986, totaling $2.9 billion.

The FNMA SMBS Trust Program and IOs and POs

The successive and current FNMA strip program, the SMBS Trust Program begun in 1987, provided a vehicle through which deal managers (e.g., investment banks) can swap FNMA passthroughs for FNMA SMBS Trust certificates. In the swapping process, eligible FNMA passthrough securities submitted by the deal managers are consolidated by FNMA into one FNMA Megapool Trust. In return, FNMA distributes to the deal manager two similarly denominated SMBS certificates evidencing ownership in the requested proportions of that FNMA Megapool Trust's principal and interest cash flows.[2]

[1] For example, a strip that receives 75% interest and 50% principal of the cash flow from a FNMA 10% would be a synthetic 15% coupon security, since the 7.50% coupon is expressed as a 100% principal (i.e., 7.50% coupon/50% principal = 15.00% coupon/100% principal). By the same logic, a strip security from a FNMA 10% that receives 50% interest and 1% principal would be a 5,000% coupon security.

[2] FNMA tightly restricts the type of collateral that can be placed in Trust. For example, all mortgage securities must have the same prefix (be of the same loan type) and be within certain a WAC and WAM

To date, the majority of FNMA SMBS Trusts have contained IO and PO securities. IOs and POs represent the most leveraged means of capturing the asymmetric performance characteristics of the two cash flow components of mortgage securities. Although IOs and POs can be combined in different ratios to create synthetic-coupon securities, some investors have shown a preference for one-certificate synthetic securities due to their bookkeeping ease. In late 1993, FNMA added another feature to their SMBS structure. In addition to IO and PO classes, FNMA SMBS Trusts contained a provision for exchanging IOs and POs for another class with a synthetic coupon. The synthetic-coupon classes that are available are determined in the prospectus supplement for each Trust and generally range from 0.5% to double the coupon on the underlying collateral in 50 basis point increments. Exchanges are executed for a small fee and may be reversed back into IO and PO components as well as into any other available combination, provided the proportions of IO and PO are correct. To promote liquidity in the SMBS market, all FNMA SMBS certificates (except FNMA SMBS Series L) have a unique conversion feature that enables like denominations of both classes of a FNMA SMBS issue or Trust to be exchanged on the book entry system of the Federal Reserve Banks for like denominations of FNMA MBS certificates or Megapool certificates. Because of the potential for profitable arbitrages, the aggregate price of the two classes of any same FNMA issue or Trust tends to be slightly higher (the "recombo premium") than the price of comparable-coupon and remaining-term FNMA passthrough certificates.

FHLMC Stripped Giant Program

FHLMC is also a participant in the SMBS market. In October 1989, FHLMC announced the Stripped Giant Mortgage Participation Certificate Program.

FHLMC's Stripped Giant Program is similar to FNMA's swap SMBS Trust Program. Deal managers submit FHLMC PCs to FHLMC; FHLMC, in turn, aggregates these PCs into Giant pools and issues Strip Giant PCs representing desired proportions of principal and interest to the deal manager. All FHLMC strip PCs have the same payment structure, payment delays, and payment guarantee as regular FHLMC PCs. Like FNMA SMBS, FHLMC Giant Strip IOs and POs have a conversion feature that allows them to be exchanged for similarly denominated FHLMC PCs. Under the FHLMC Gold MACS (Modifiable and Combinable Securities) program, IO and PO securities may be exchanged for synthetic-coupon classes that have been predetermined in the prospectus supplement for a fee.

GNMA Collateral for SMBS

In 1990 FNMA began to issue SMBS collateralized by GNMA passthrough certificates. Since the beginning of 1990, FNMA has issued 76 trusts that have had underlying GNMA collateral. FHLMC began to issue GNMA-backed SMBS in 1993 and has issued

range to correspond with preliminary pricing. Moreover, the minimum initial principal balance of each SMBS Trust must be $200 million.

seven GNMA strips to date. The increased availability of GNMA SMBS has further broadened the investor base of SMBS, enhanced the liquidity of the SMBS market, and increased the number of hedging alternatives available to GNMA investors.

In July 2004, GNMA issued its first Trust security GNS 1 of $2.2 billion. Although very few GNMA SMBS have been issued subsequently, structured IO and PO within GNMA-backed CMOs are very popular.

Private Issuance

Investment firms began to issue private-label SMBS in late 1986. Many of these private-labels SMBS were issued through REMIC structures. Since one class of REMIC issue must be designated the residual interest, the super-premium coupon class of many of these private-label SMBS is often the residual interest of the REMIC deal. Unlike investing in FNMA SMBS, investors who purchase these residual securities are responsible for the tax consequences of the entire REMIC issue.

PO-Collaterized CMOs

Profitable arbitrage opportunities led to the introduction of CMO securities collateralized by POs. PO-collateralized CMOs allocate the cash flow from underlying PO securities between several CMO tranches with different maturities and prepayment patterns. The potential for profitable arbitrages with PO securities has enhanced the efficiency of the SMBS market by effectively placing a floor on the price potential of POs and a price ceiling on corresponding IOs in a given market environment.

CMO Strip Securities

Strip securities are included in CMO issues as regular-interest (nonresidual) CMO tranches. CMO strip securities that pay only principal, large proportions of interest cash flows (relative to principal cash flows), or only interest over the underlying mortgage collateral's life are termed PO securities, "higher-interest" securities, and IO securities respectively; they tend to have performance characteristics similar to FNMA SMBS. Other types of CMO strip securities receive initial and ongoing collateral principal or interest in cash flows after other classes in the CMO issue are retired or have been paid. These types of strip CMO securities are structured as PO or PAC IOs, TAC IOs, or Super-POs and can have similar characteristics to FNMA SMBS or can be structured to have higher or lower performance leverage.

IOS Index

In February 2010, Markit introduced the IOS Index. The IOS Index is a Synthetic Total Return Swap. The IOS Index has gained in popularity in recent years as a source for IO exposure. The Markit IOS Indices are composed of the interest component of reference pools of loans. The most common reference pools of loans are 30-year fixed-rate Fannie pools with coupons from an entire issue year. For example, the first pools were issued with coupons of 4.0, 4.5, and 5.0 in 2009. Today there are various reference pools from 3.0 fixed-rate coupon to 6.5 fixed-rate coupon with vintage years from 2003 to 2014.

The economics of the IOS Index is similar to that of owning a cash IO. If an investor buys the IOS index of 2009 4.5 coupon, they will receive the net cash flow based on the reference pool and will pay 1-month LIBOR in return.

In 2014, the volume of IOS trading averaged approximately $2 billion weekly.

Buyers of SMBS

The asymmetric returns of SMBS appeal to a broad variety of investors. SMBS can be used effectively to hedge interest rate and prepayment exposure of other types of mortgage securities. Combined with interest rate derivatives, SMBS is a typical instrument for mortgage servicers to hedge the interest rate and prepayment exposure of the mortgage servicing rights. SMBS can also be combined with other fixed-income securities such as US Treasuries and mortgage securities to enhance the total return of the portfolio in varying interest rate scenarios. Insurance companies and pension funds frequently use SMBS as a method of tailoring their investment portfolio to meet the duration of liabilities and thus minimize interest rate risk.

SMBS are used by various types of investors to accomplish their investment objectives. Insurance companies, pension funds, money managers, hedge funds, and other total rate of return accounts use SMBS to improve the return of their fixed-income portfolios.

Investment Characteristics

SMBS enable investors to capture the performance characteristics of the principal or interest components of the cash flows of mortgage passthrough securities. These individual components display contrasting responses to changes in interest rates and prepayment rates. Principal-only (PO) SMBS are bullish instruments, outperforming mortgage passthrough in declining interest rate environments. Interest-only (IO) SMBS are bearish investments that can be used as a hedge against rising interest rates.

Variation of Interest and Principal Components with Prepayments

The cash flows that an MBS investor receives each month consist of principal and interest payments from a large group of homeowners. The proportion of principal and interest in the total payment varies depending on the prepayment level of the mortgage pool. Figure 18.2 illustrates these cash flows for $1 million 30-year FNMA current-coupon passthrough securities at various PSA prepayment speeds.

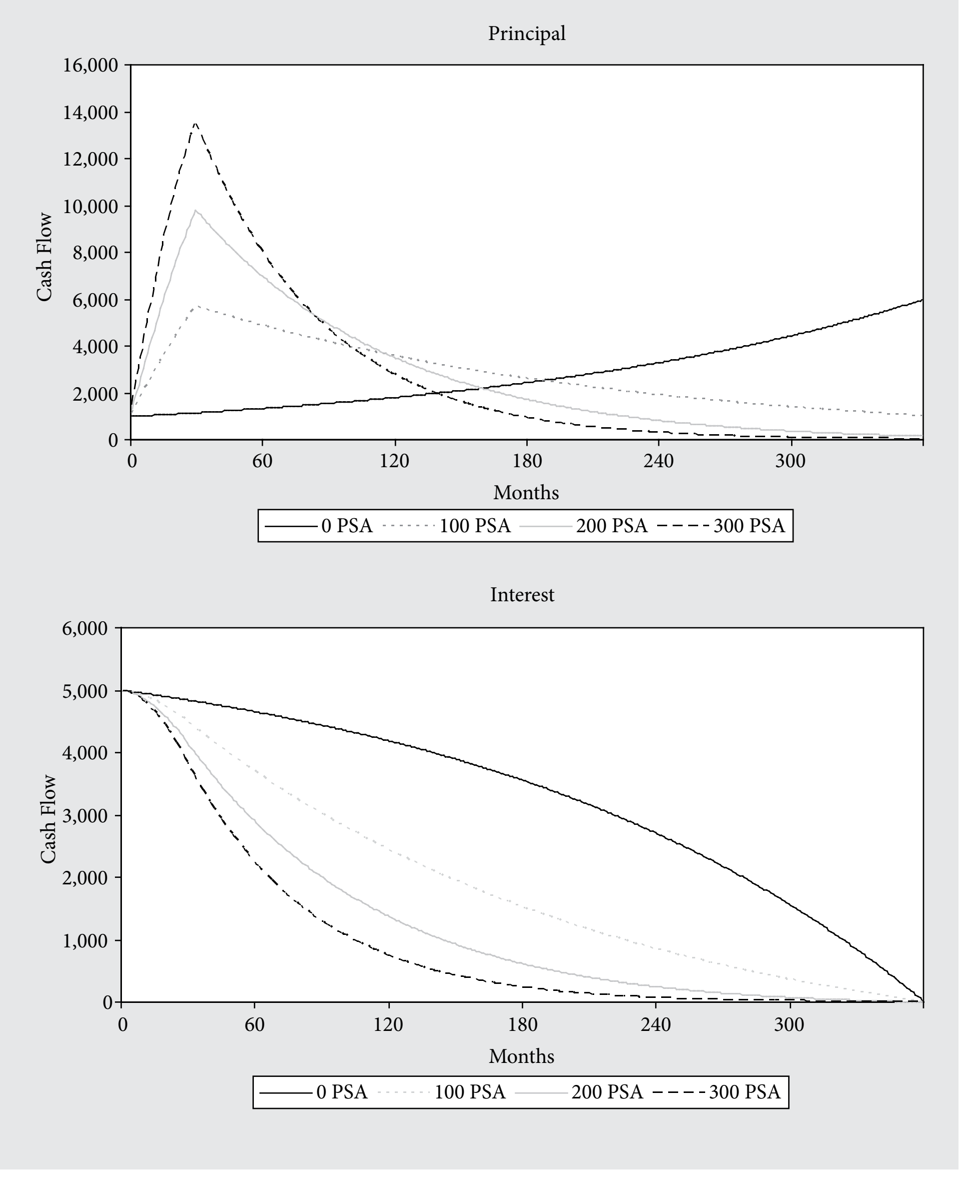

FIGURE 18.2 Monthly principal and interest components

Panel a: Principal component of monthly cash flows
Panel b: Total amount of interest cash flows

Panel a of Figure 18.2 shows the principal component of the monthly cash flows. Since the interest is proportional to the outstanding balance, the figure can also be viewed as showing the decline in the mortgage balance at the various prepayment speeds.

At a zero prepayment level, the interest and principal cash flows in Figure 18.2 compose a normal amortization schedule. In the earlier months of the security's life, the cash flows primarily contain interest payments. This occurs because interest payments are calculated based on the outstanding principal balance remaining on the mortgage loans at the beginning of each month. As the mortgage loans amortize, the cash flows increasingly reflect the payment of principal. Toward the end of the security's life, principal payments make up the bulk of the cash flows.

Prepayments of principal significantly alter the principal and interest cash flows received by the mortgage passthrough investor. Homeowners who prepay all or part of their mortgage loans return more principal to the investor in the earlier years of the mortgage security. All else being equal, an increase in prepayments has two effects:

1. The time remaining until return of principal is reduced as shown in panel a of Figure 18.2. At 100% PSA, the average life of the principal cash flows is 11.3 years, whereas at faster speeds of 200 and 300% PSA, principal is returned in average time periods of 7.6 years and 5.7 years, respectively.
2. The total amount of interest cash flows is reduced, which is shown in panel b of Figure 18.2. This occurs because interest payments are calculated based on the higher amount of principal outstanding at the beginning of each month and higher prepayment levels reduce the amount of principal outstanding.

Effect of Prepayment Changes on Value

A mortgage passthrough security represents the combined value of the interest and principal cash flows. The effects of prepayments on the present value of each of these components tend to offset each other. Increases in prepayments reduce the time remaining until repayment of principal. The sooner the prepayment of principal is repaid, the higher the present value of the principal. Conversely, since increasing levels of prepayments reduce interest cash flows, the value of the interest decreases.

Thus, the interest and principal cash flows individually are much more sensitive to prepayment changes than the combined mortgage passthrough. This is illustrated in Figure 18.3, which shows the present values of the principal and interest components of a FNMA current coupon passthrough at various prepayment levels.

The greater sensitivity of IOs and POs to prepayment changes is further illustrated in Figure 18.4, which shows the realized yields to maturity (or internal rates of return) for a typical IO and PO and for the underlining collateral for given purchase prices.

The IO and PO reflect sharply contrasting responses to prepayment changes; the IO's yield falls sharply as prepayments increase, whereas the PO's yield falls sharply as prepayments decrease. The yield of the underlining collateral is, on the other hand, relatively stable since it is assumed to be priced close to par.

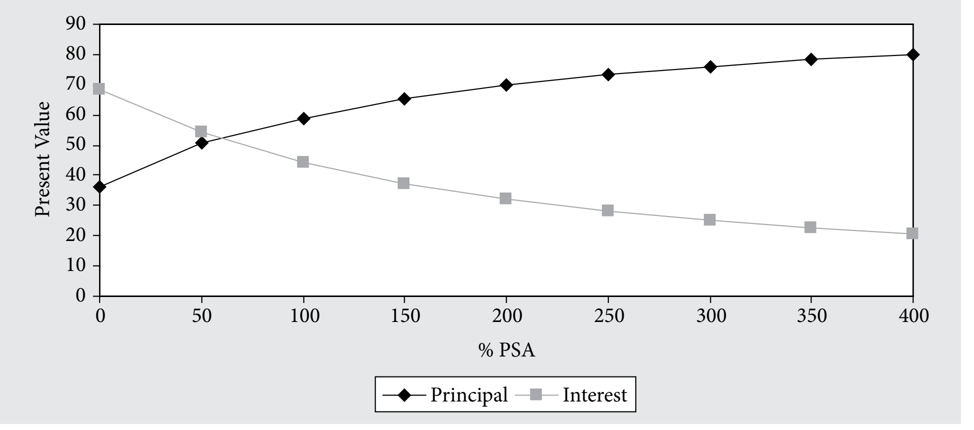

FIGURE 18.3 Present values of principal and interest components of FNMA current-coupon passthrough

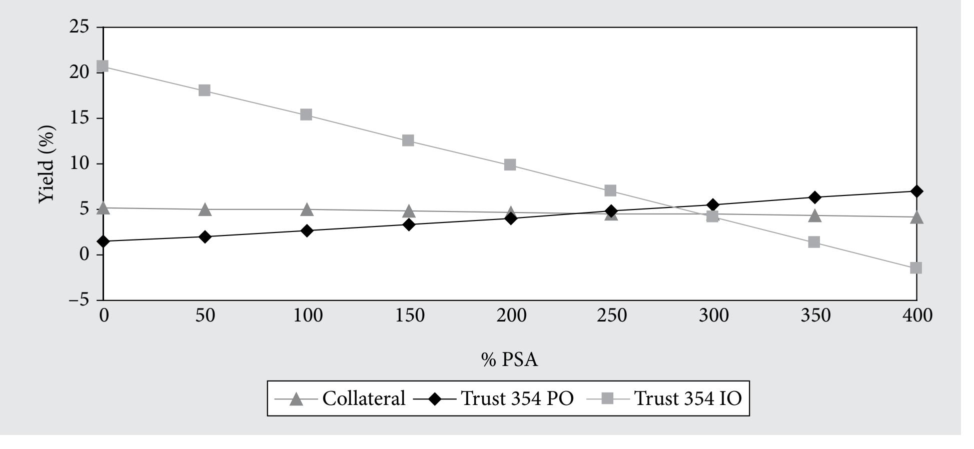

FIGURE 18.4 Realized yields to maturity for typical IO and PO

Price Performance of SMBS

The discussion in the previous section indicates that prepayment speeds are by far the most important determinant of the value of an SMBS. Since the price response of an SMBS to interest rate changes is determined, to a large extent, by how the collateral's prepayment speed is affected by interest rate changes, we begin with a discussion of mortgage prepayment behavior.

The Prepayment S-Curve

The prepayment speed of an MBS is a function of the security's characteristics (such as coupon and age), interest rates, and other economic and demographic variables.[3]

[3] Prepayment modeling is discussed in other chapters.

Although detailed prepayment projections generally require an econometric model, the investor can obtain some insight into the likely behavior of an SMBS by examining the spread between the collateral's gross coupon and current mortgage rates.

This spread is generally the most important variable in determining prepayment speeds. With respect to this spread, prepayment speeds have an S shape; speeds are fairly flat for discount coupons (when the spread is negative and prepayments are caused mainly by housing turnover), they start increasing when the spread becomes positive, they surge rapidly until the spread is several hundred basis points, and then they level off when the security is a high premium. At this point, there is already substantial economic incentive for mortgage holders to refinance, and further increases in the spread lead to only marginal increases in refinancing activity. This S-curve is illustrated in Figure 18.5, which shows projected long-term prepayments for current coupon collateral for specified changes in mortgage rates.

In the remainder of this section, we make repeated reference to Figure 18.6, since the performance of an SMBS can be explained to a large extent by the position of its collateral on the prepayment S-curve.[4]

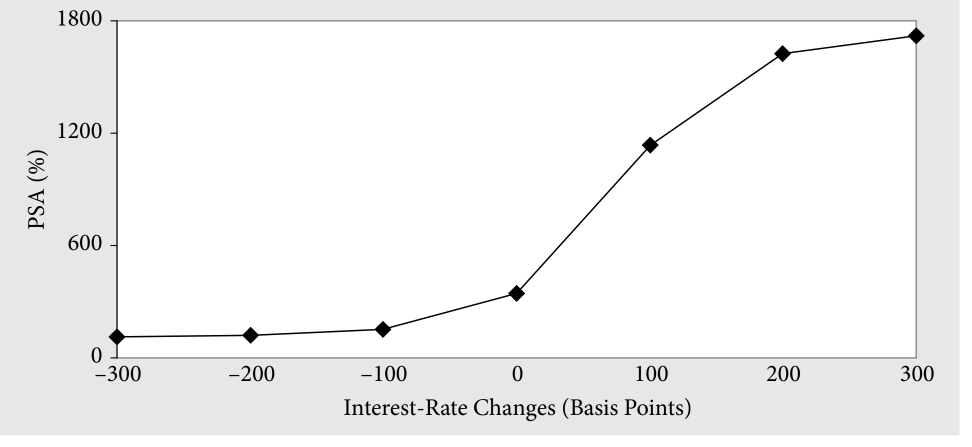

FIGURE 18.5 Prepayment S-curve

[4] However, the investor should note that not all aspects of prepayment behavior are explained by the spread between the coupon and the mortgage rate. The projected prepayments shown in Figure 18.6 are long-term averages. Month-to-month prepayment rates vary (for example, due to seasonality) even if mortgage rates do not change. If a substantial and sustained decline in mortgage rates occurs, then mortgage holders exposed to mortgage refinancing incentives for the first time initially exhibit a sharp increase in prepayments. This gradually decreases as the homeowners most anxious and able to refinance do so. This non-interest-rate-related decline in the prepayment speeds of premium coupons usually is referred to as "burnout." The projected speeds shown in the declining-rate scenarios are the average of the high early speeds and lower later speeds. For seasoned coupons that have experienced a heavy refinancing period, burnout implies that prepayments may be less responsive to decline in interest rates. This applies to the majority of premium coupons currently outstanding. The age effect on prepayments is well known. Prepayment speeds are low for new mortgages and increase gradually until the mortgages are two to three years old, after which the age is less important. This means that, other things being equal, an IO is worth more if it is collaterized by new FNMA 5.5s, for example, than by seasoned FNMA 5.5s.

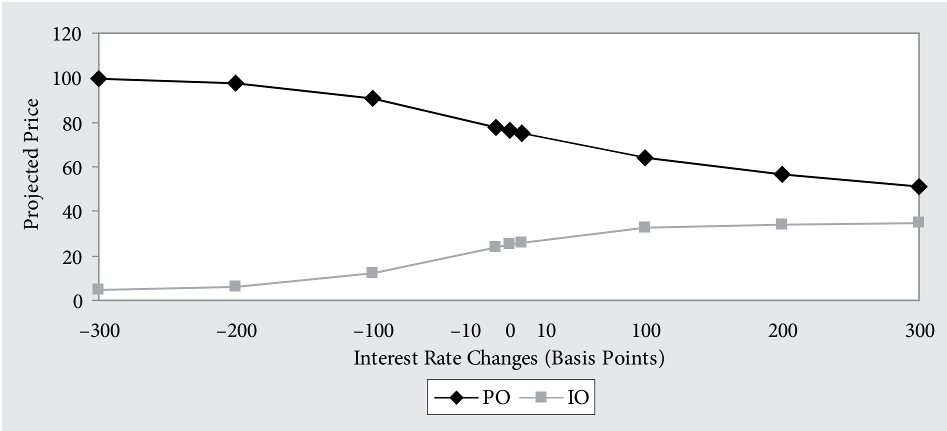

FIGURE 18.6 Projected price paths for a current-coupon IO and PO for parallel interest rate shifts

Projected Price Behavior

Figure 18.6 gives projected price paths for a current coupon IO and PO for parallel interest rate shifts.[5]

The projected price behavior of the SMBS as interest rates change can be explained largely by the prepayment S-curve in Figure 18.5.

- As rates drop from current levels, the collateral begins to experience sharp increases in prepayment. Compounded by lower discounted rates, this causes substantial price appreciation for the PO. For the IO, however, the higher prepayments outweigh the lower discount rates and the net result is a price decline.
- If the rates drop by several hundred basis points, the collateral becomes a high-premium coupon and prepayments plateau. The rates of price appreciation of the PO and price deprecation of the IO both decrease. Eventually the IO's price starts to increase, as the effect of lower discount rates starts to outweigh the effect of marginal increases in prepayments.
- If rates rise, the slower prepayments and higher discount rates combine to cause a steep drop in the price of the PO. The IO is aided initially by the slower prepayments, giving the IO negative duration, but eventually prepayments plateau on the slower side of the prepayment S-curve and the IO's price begins to decrease.

Effective Duration and Convexity

Figure 18.6 indicates that for current- or low-premium collateral, POs tend to have large positive effective durations whereas IOs have large negative effective durations.[6]

[5] The prices are calculated to give a LIBOR option-adjusted spread (LOAS) of –15 basis points in all cases. A discussion of OAS analysis is given in the next section. Note that if it is also priced at an LOAS of –15 basis points, the collateral price is just the sum of the IO and PO prices.

[6] Effective duration is a measure of the proportional price change if interest rates change by a small amount. Let Price(0) be the current price of a security. Let Price(Δ) be the price if interest rates

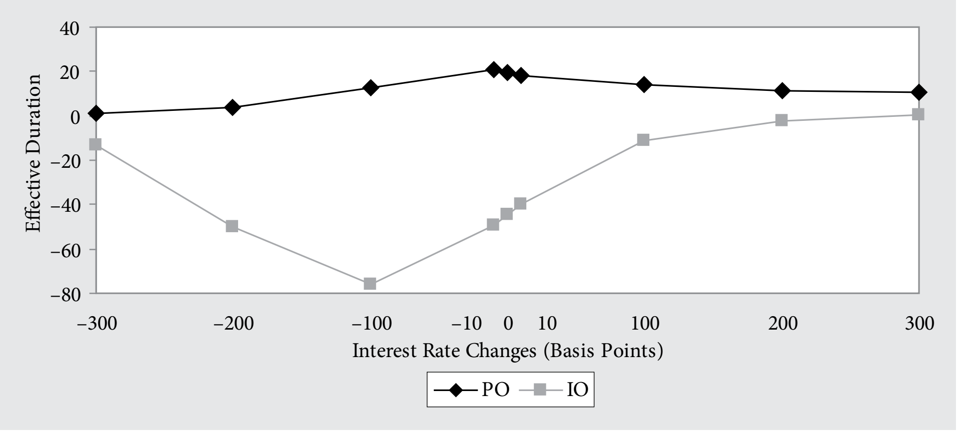

FIGURE 18.7 IO and PO effective durations for current- or low-coupon collateral

The effective durations in Figure 18.7 reflect the price paths in Figure 18.6:

- For the PO, as rates decline, the effective duration initially increases, reflecting its rapid price appreciation as prepayments surge. Note that this is in complete contrast to traditional measures such as Macaulay or modified duration, which, reflecting the shortening of the PO, would actually decrease. As rates continue to drop, the PO's effective duration levels off and then decreases, reflecting both a leveling off of prepayments and the fact that, to calculate the effective duration, we are dividing by an increasing price. If rates increase, the PO's duration decreases but remains positive.
- For the IO, the effective duration is initially negative and decreases rapidly as rates drop, before eventually increasing and becoming positive after prepayments plateau. If rates increase, the duration increases and eventually becomes positive.

Convexity measures the rate of change of duration and is useful in indicating whether the trend in price change is likely to accelerate or decelerate. It is calculated by comparing

increase by a small amount Δy and Price($-\Delta$) be the price if interest rates decrease by a small amount Δ. Then

$$\text{Effective duration} = \frac{\text{Price}(-\Delta) - \text{Price}(\Delta)}{\text{Price}(0) \times 2\Delta y} \times 100$$

This formula is straightforward: we take the total price change (the difference in the new prices) and divide by the initial price (the 100 is a scaling factor). To obtain the projected price and durations, we have, for simplicity, assumed parallel shifts in interest rates. In practice, of course, rates do not move in parallel (typically, short-term rates tend to be more volatile than long rates). However, using nonparallel yield curve shifts raises questions which, although interesting, are best left for another book. For example, suppose the yield curve shifts such that short rates move twice as much as long rates, and we compute the corresponding price change. The effective duration will be twice as large if we compare the price change against the change in short rates (i.e., Δy change in short rates) as opposed to comparing the price change against the change in long rates (i.e., Δy change in long rates).

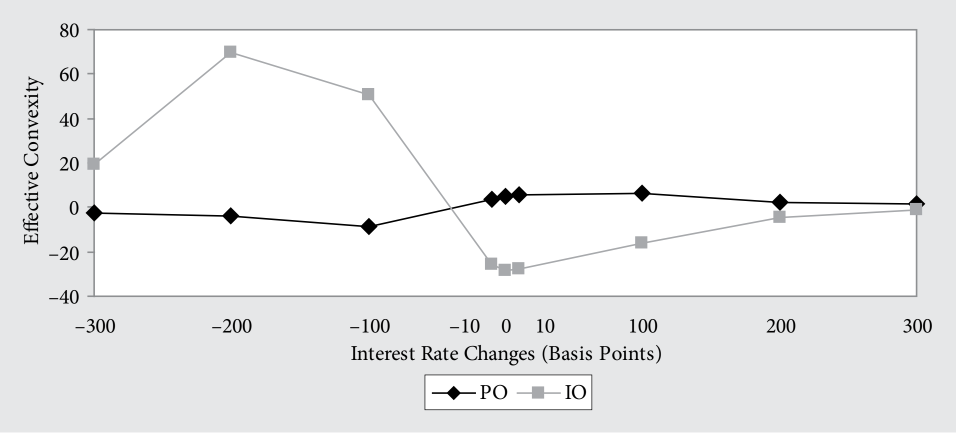

FIGURE 18.8 IO and PO convexities

the price change if interest rates decrease with the price change if rates increase.[7] Figure 18.8 shows the convexities obtained using the projected prices in Figure 18.6.

Comparing Figures 18.6 and 18.7 shows that the convexity indicates how the duration is changing. When the duration is increasing (as in the case of the PO when rates begin to decline from the initial value), the convexity is positive, and when the duration is decreasing, the convexity is negative. For example, the IO's convexity is initially negative but begins to increase after rates fall by more than 100 basis points; although the duration is still negative at 200 basis points, the positive convexity indicates that the duration is increasing. The peak in the convexity of the IO at a change of 200 basis points indicates that the rate of increase in its duration is greatest at this point, as shown in Figure 18.7.

In summary, the prepayment S-curve implies that for SMBS collateralized by:

- current or discount passthroughs, the PO has substantial upside potential and little downside risk, whereas the converse is true for IOs;
- low premiums, there is a somewhat comparable upside potential and downside risk;
- high premiums (including the majority of SMBS issued to date), the PO has little upside potential and significant downside risk whereas the reverse is true for IOs.

[7] Convexity is calculated by comparing the price change if rates move up or down by small amounts. Let

$$\Delta P^{+} = \text{Price}(0) - \text{Price}(\Delta)$$
$$\Delta P^{-} = \text{Price}(-\Delta) - \text{Price}(0)$$

where ΔP^{+} and ΔP^{-} are the price changes if rate increases or decreases by $\Delta\, y$, respectively. Then

$$\text{Convexity} = \frac{\Delta P^{-} - \Delta P^{+}}{\text{Price}(0) \times (\Delta y)^{2}} \times 100$$

Pricing of SMBS and Option-Adjusted Spreads

The strong dependence of SMBS cash flows on future prepayment rates, combined with the typically asymmetric response of prepayments to interest rate changes, make traditional measures of return such as yield to maturity of limited usefulness in analyzing or pricing SMBS. The most common method of pricing SMBS is with option-adjusted spreads (OASs). OAS analysis uses probabilistic methods to evaluate the security over the full-term range of interest rate paths that may occur over its term. The impact of prepayment variations on the security's cash flows is factored into the analysis. The OAS is the option-free spread over the benchmark curve (Treasury or swap curve) provided by the security.[8] It gives a long-term average value of the security, assuming a market-neutral viewpoint on interest rates.

Table 18.1 shows the use of OAS analysis for FNMA Trust 354 and FNMA Trust 293 and the underlining passthrough collateral. In each case, the price is chosen to give a LIBOR OAS (LOAS) of –15 basis points. Also shown are the yields to maturity, WAL, spread to WAL equivalent swap rate.

The OAS at a 0% volatility (the Z-Spread) when mortgage rates stay at current levels, is typically close to the standard benchmark curve spread in a flat yield curve environment. The difference between the Z-Spread and LOAS, which we label the *option cost*, is a measure of the impact of prepayment variations on a security for the given level of interest rate volatility. The option cost, to a large extent, does not depend on the pricing level or the absolute level of prepayment projections (although it does depend on the slope, or response, of prepayment projections to interest rate changes). Hence, the option cost is a measure of the intrinsic effect of likely interest rate changes on an SMBS.

Before discussing the option cost in Table 18.1, note that, in general, interest rate and prepayment variations have two effects on an MBS:

Table 18.1 OAS analysis for FNMA Trust 354 and FNMA Trust 293

	Price	YTM	WAL	Spread	LOAS	Z-Spread	Option Cost
FNS 354 PO	76-06	5.073	6.21	–85	–15	–114	–99
FNS 354 IO	25-03	5.489	6.21	601	–15	593	608
Collateral PT	101-06	5.211	6.21	78	–15	57	72
	Price	YTM	WAL	Spread	LOAS	Z-Spread	Option Cost
FNS 293 PO	83-21	4.824	4.11	–24	–15	–59	–44
FNS 293 IO	20-30	3.723	4.11	468	–15	452	467
Collateral PT	104-12	4.561	4.11	61	–15	50	65

[8] See Chapter 24.

1. For any callable security, being called in a low interest rate environment typically has an adverse effect, since a dollar of principal of the security in general would be worth more than the price at which it is being returned. (An exception is a mortgage prepayment resulting from housing turnover, when the call could be uneconomic from the call-holder's point of view.) To put it another way, the principal that is being returned typically has to be reinvested at yields lower than that provided by the existing security.
2. For MBS priced at a discount or a premium, changes in prepayments result in the discount or premium being received sooner or later than anticipated. This may mitigate or reinforce the call effect discussed in (1).

In general, the first effect is much more important than the second; however, for certain deep-discount securities, such as POs, the second effect may at times outweigh the first. The net result of the two effects depends on the position of the collateral on the prepayment curve shown in Figure 18.4.

- FNMA Trust 354, shown in Table 18.1, illustrates the characteristics typical of SMBS collateralized by current or discount coupons. For discount or current-coupon collateral, prepayments are unlikely to fall significantly but could increase dramatically if there is a substantial decrease in interest rates. This asymmetry means that the PO is, on average, likely to gain significantly from variations in prepayment speeds. The option cost for the PO is usually negative; that is, the PO *gains* from interest rate volatility, indicating that the benefits of faster return of principal outweigh the generic negative effects of being called in low interest rate environments. On the other hand, the underlying collateral tends to have a positive (but usually small in the case of discount collateral) option cost; the negative effects of being called when rates are low outweigh the benefits of faster return of principal. Finally, the IO typically has a large positive option cost; the asymmetric nature of likely prepayment changes, discussed above, means that the IO gains little if interest rates increase (since prepayments will not decrease significantly), whereas a substantial decline in rates is likely to lead to a surge in prepayments and a drop in interest cash flows.
- FNMA Trust 293 is representative of outstanding SMBS with premium collateral. For *premium* collateral, there is, generally speaking, potential for both increases and decreases in prepayments, and the net effect of prepayment variations will depend on the particular coupon and prevailing mortgage rates. Seasoned premiums, for example, will not have potential for substantial increases in speeds, and hence FNMA Trust 293 PO has a less negative option cost. The collateral has a positive option cost for the same reasons.

The importance of likely variations in prepayments makes the standard yield to maturity of very little relevance in pricing SMBS, and therefore they tend to be priced (as in Figure 18.8) on an OAS basis.

Key Points

- There are many forms of stripped mortgage-backed securities, including passthroughs, Trust IOs and POs, and CMO strips.
- SMBS are used both as hedges of prepayment and interest rate risk and as yield enhancement mechanisms.
- POs and IOs exhibit contrasting responses to changes in interest rates: POs outperform mortgage passthroughs in a declining rate environment while IOs underperform them.
- Prepayment speeds are by far the most important determinant of the value of an SMBS. As such, the price performance of SMBS is largely determined by the prepayment S-curve.
- Current- or low-premium collateral POs tend to have large positive effective durations, while IOs have large negative effective durations.
- Traditional performance measures such as yield to maturity have limited usefulness in the analysis of SMBS; the most common method of pricing them is using an option-adjusted spread.

PART IV

PRIVATE-LABEL MBS

CHAPTER 19

LESSONS OF THE FINANCIAL CRISIS FOR PRIVATE-LABEL MBS

MARK ADELSON

AFTER reading this chapter you will understand:

- how the financial crisis affected the general economy and the mortgage sector;
- how loan origination practices deteriorated at several leading lenders;
- how the deterioration was probably widespread throughout the mortgage lending industry;
- how loan origination volumes surged during the inflation of the bubble;
- how private-label MBS issuance surged during the inflation of the bubble and later stalled after the bubble burst;
- how foreclosures and modifications of defaulted loans surged after the bubble burst, causing defaults of many private-label MBS;
- how a lender's mortgage loan underwriting process needs to apply systematic and rigorous procedures to produce consistent and replicable results;
- that there are historical examples of US housing bubbles before the mid-2000s and that they tend to end with significant home price declines;
- that the re-default rate on modified loans (i.e., loans that received modifications following default) is quite high;
- that the federal securities laws may provide little real protection to investors in private-label MBS;
- that state securities laws and contractual representations and warranties have been sources of substantial protection;
- that disclosure standards and offering procedures for private-label MBS are changing, but it is too soon to tell what the effect on investor protection will be.

This chapter discusses the lessons of the 2008 financial crisis for private-label MBS. The chapter is organized in two main parts. The first part examines what happened in the financial crisis. It considers both what happened in the general economy and the evolution of the mortgage sector from the mid-2000s housing bubble, though the crisis, and into its aftermath. The second part of the chapter focuses on the lessons from the crisis. It highlights the importance of loan underwriting and also discusses other key lessons.

What Happened in the Financial Crisis?

The mortgage industry did not cause the 2008 financial crisis, nor did the financial crisis cause the problems that occurred in the mortgage industry. Rather, a common set of causes produced effects in both the broad financial sector and in the mortgage sector. The proximate causes of the financial crisis were the behaviors of financial firms, particularly high leverage and strong risk appetite. Those, in turn, reflected a set of deeper causes, with roots stretching back decades. The deeper causes included: (1) securities firms converting from partnerships to corporations, (2) the 30-year trend of deregulation, (3) the quant movement, (4) the spread of risk-taking culture through the financial industry, and (5) globalization.[1]

The Effects on the General Economy

The 2008 financial crisis had significant economic effects, both in the US and around the globe. It caused the US unemployment rate to spike up to 10%, a level not experienced since the 1980s. It also caused a slight contraction of US output in 2008 and a significant contraction in 2009 (Figure 19.1).

FIGURE 19.1 US unemployment rate and annual change in real GDP (%)

Source: Stanley Lebergott, "Annual Estimates of Unemployment in the United States, 1900–1954," in *The Measurement and Behavior of Unemployment* (National Bureau of Economic Research, 1957), 215–16 (annual unemployment rates from 1900 through 1946); US Bureau of Labor Statistics (series LNS14000000) (monthly unemployment rates from 1947); US Bureau of Economic Analysis (annual change in US real GDP from 1930 through 2013)

[1] Mark Adelson, "The Deeper Causes of the Financial Crisis: Mortgages Alone Cannot Explain It," *Journal of Portfolio Management* 39/3 (Spring 2013), 16–31.

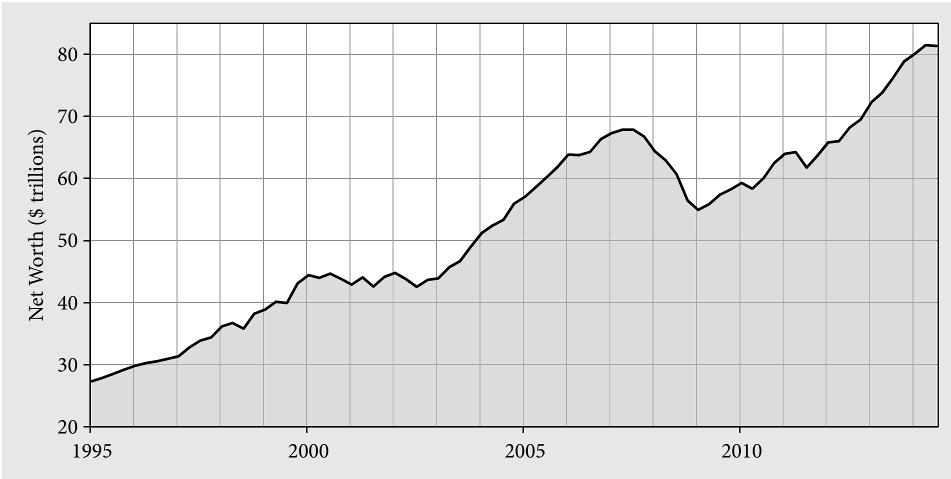

FIGURE 19.2 Net worth of US households and nonprofit organizations

Source: Board of Governors of the Federal Reserve System, "Households and Nonprofit Organizations; Net Worth, Level [TNWBSHNO]," retrieved from FRED, Federal Reserve Bank of St. Louis (December 26, 2014)

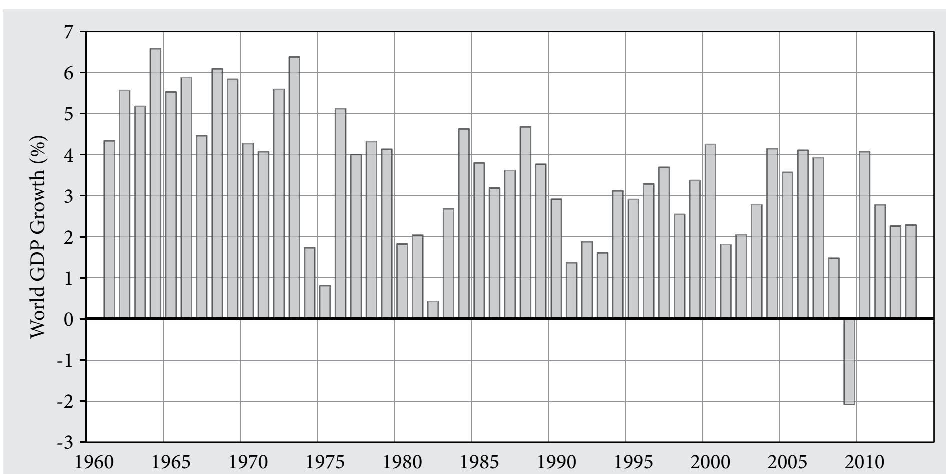

FIGURE 19.3 World GDP growth (%)

Source: World Bank, data series NY.GDP.MKTP.KD.ZG (May 10, 2015)

The financial crisis caused a temporary decline of more than $10 trillion in the net worth of US households and nonprofit organizations (see Figure 19.2). From a global perspective, the financial crisis brought a contraction of roughly 2% in the GDP of the entire world in 2009 (see Figure 19.3).

The crisis pushed a number of major financial firms to the brink of failure, and several actually went over the edge. The roster of troubled names included not only broker dealers such as Lehman Brothers, Bear Stearns, and Merrill Lynch, but also banks like Citibank, Washington Mutual, Royal Bank of Scotland, Northern Rock, Union Bank of

Switzerland, and Wachovia. The insurance sector was not immune. It took its most visible blows at AIG and also endured the near-total collapse of the bond insurance subsector. Government-sponsored mortgage giants, Fannie Mae and Freddie Mac, were forced into conservatorship.

However, by mid-2015 the US economy, the world economy, and the financial sector had largely recovered from the crisis. The US unemployment rate has come back down, US and world economic growth have resumed, US household wealth has recovered, and the banking sector has substantially recovered. Pockets of difficulty certainly remain—Fannie Mae and Freddie Mac remain in conservatorship and the bond insurance sector has definitely not rebounded—but for most people the financial crisis is more of memory than a present experience.

What Happened in the Mortgage Sector

Heightened acceptance of leverage and risk was not confined to banks and securities firms. Investors, investment advisors, and rating agencies were also affected. An extended period of benign conditions starting in the late 1990s—particularly in the mortgage and real estate sectors—helped reinforce the belief that new financial products (e.g., credit default swaps) and quantitative models had finally conquered credit risk. Of course, later events showed that belief to have been entirely mistaken.

The years preceding the financial crisis brought a breakdown in market-based restraints on lenders' behavior. Starting around 2004, collateralized debt obligations

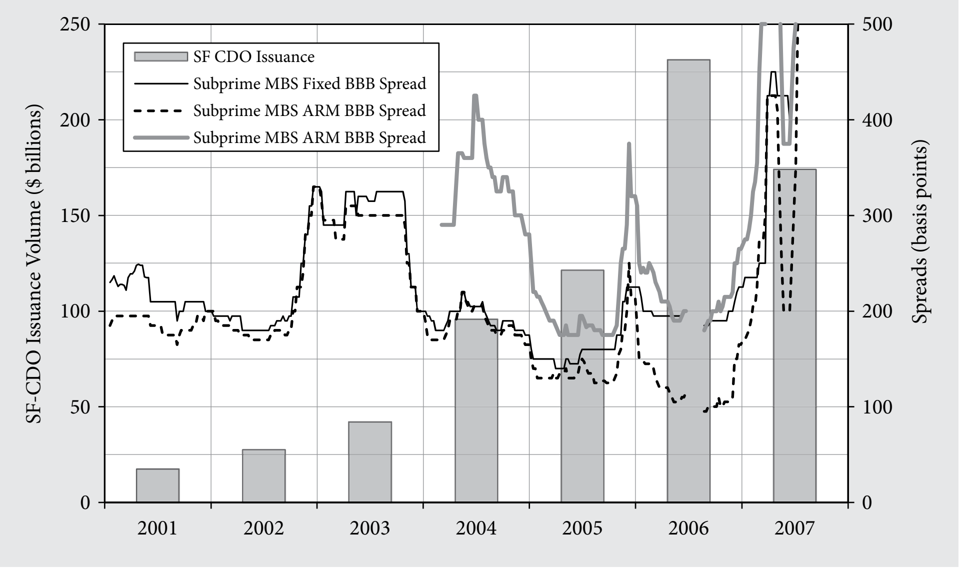

FIGURE 19.4 SF CDO issuance volume and selected subprime MBS spreads

Source: JP Morgan

backed by structured finance securities (SF-CDOs) started to replace bond insurers and traditional investors as the dominant class of market participants absorbing the risk on subordinate tranches of subprime mortgage deals. The SF-CDOs had seemingly insatiable appetites for mortgage risk, and they bid credit spreads to unprecedentedly tight levels (see Figure 19.4).

The SF-CDOs drove the bond insurers and the traditional subordinate-tranche buyers to the sidelines. That was a key event because the SF-CDOs were less discriminating and selective about taking risk than the traditional investors or the bond insurers. The SF-CDOs accepted risky loans in securitizations that the traditional investors and bond insurers would have rejected. This produced a breakdown in restraints on lenders' behavior. Without those restraints, lenders started originating riskier and riskier loans for inclusion in private-label MBS.[2]

Loan Origination Practices Deteriorate

The breakdown in discipline was not confined to the subprime mortgage area. It affected the entire US residential mortgage landscape. The breakdown of discipline was expressed not only through a loosening of underwriting standards, but also in generally shoddy origination practices. In some subsectors, certain lenders all but abandoned their underwriting standards and essentially originated loans without underwriting.

A small taste of the shoddy practices can be seen in the factual statements included in the settlement agreements that the US Department of Justice (DOJ) entered into with some of the major players in the mortgage market. For example, the statement of facts in the DOJ settlement with JP Morgan states:

> Through that due diligence process, JP Morgan employees were informed by due diligence vendors that a number of the loans included in at least some of the loan pools that it purchased and subsequently securitized *did not comply with the originators' underwriting guidelines*, and, in the vendors' judgment, did not have sufficient compensating factors, and that a number of the properties securing the loans had appraised values that were higher than the values derived in due diligence testing from automated valuation models, broker price opinions or other valuation due diligence methods. In addition, JP Morgan represented to investors in various offering documents that loans in the securitized pools were originated "generally" in conformity with the loan originator's underwriting guidelines; and that exceptions were made based on "compensating factors," determined after "careful consideration" on a "case-by-case basis." . . . Notwithstanding these representations, in certain instances, at the time these representations were made to investors, *the loan pools being securitized contained loans that did not comply with the originators' underwriting guidelines*.[3]

[2] Mark Adelson, "The Subprime Problem: Causes and Lessons," *Journal of Structured Finance* 14/1 (Spring 2008), 12–17.

[3] Settlement Agreement among the United States et al. and JP Morgan Chase & Co., Annex 1 (January 7, 2014), p. 2 (footnote omitted, emphasis added), <http://www.justice.gov/iso/opa/resources/9432013111915l031990622.pdf>.

In addition, the statement of facts covers activities by Bear Stearns, before it was acquired by JP Morgan. For example, it provides:

> In certain circumstances, Bear Stearns due diligence managers or other employees determined after their review of the loans that, notwithstanding a vendor's identification of exceptions to specified underwriting guidelines, Bear Stearns would purchase loans where there was a variance from the guidelines that the managers or other employees deemed acceptable. In addition, Bear Stearns completed bulk purchases of Alt-A loan pools even though the rate of loans with exceptions in the due diligence samples indicated that the un-sampled portion of a pool likely contained additional loans with exceptions.[4]

The statement of facts in the DOJ settlement agreement with Citigroup is just as interesting. It provides that:

> In securitizing and issuing the [residential MBS], Citigroup provided representations in offering documents about the characteristics of the underlying loans. As described below, in the due diligence process, Citigroup received information indicating that, for certain loan pools, significant percentages of the loans reviewed did not conform to the representations provided to investors about the pools of loans to be securitized.[5]

The statement of facts specifically addressed Citigroup's practices regarding appraisals that overvalued the subject properties:

> Citigroup used thresholds or "tolerances" for the valuation firm to assess whether the information about the property's value sufficiently supported the reported value as determined by an appraiser. Citigroup instructed the vendor to recommend the loan for rejection if the vendor's valuation determination differed from the appraised value by more than 15 percent with respect to certain types of loans. In other words, Citigroup had an internal "tolerance" of up to 15 percent. *This meant that Citigroup routinely accepted, for purposes of the valuation review, specific types of loans for purchase and securitization when the valuation firm's determination deviated by less than 15 percent from the reported appraised value.* Citigroup's thresholds further provided that if a valuation firm determined that the combined loan-to-value ratio for a loan exceeded 100 percent, the loan would be recommended for rejection.[6]

The statement of facts in the DOJ settlement agreement with Bank of America is perhaps the most interesting. It covers actions by Countrywide and Merrill Lynch before B-of-A acquired those firms. The parts about Countrywide include colorful terms such as "Shadow Guidelines" and "Extreme Alt-A." For example, describing the role of the Shadow Guidelines, the statement of facts provides:

> When branch underwriters received loan applications that did not meet the program parameters in the Loan Program Guides (e.g., credit score, LTV, loan amount), the branch underwriters were authorized to refer the applications to more experienced

[4] Ibid., p. 10.

[5] Settlement Agreement among the United States et al. and Citigroup Inc., Annex 1 (July 11, 2014), p. 1, <http://www.justice.gov/iso/opa/resources/558201471413645397758.pdf>.

[6] Ibid., p. 4 (emphasis added).

> underwriters at the relevant divisional "Structured Loan Desk" ("SLD") for consideration of an "exception." Underwriters at the SLD were authorized to approve requests to make an "exception" to the Loan Program Guides if the proposed loan and borrower complied with the characteristics described in another set of guidelines, referred to as so-called "Shadow Guidelines," and the loan contained compensating factors supporting the exception request. The Shadow Guidelines generally permitted loans to be made to borrowers with lower credit scores and allowed for higher LTV ratios than the Loan Program Guides. . . .
>
> If a loan application did not meet the credit standards of the Shadow Guidelines, Structured Loan Desk underwriters were authorized to submit a request to Countrywide's Secondary Marketing Structured Loan Desk ("SMSLD"), which would then determine whether the requested loan, if originated, could be priced and sold in the secondary market. If a loan could be priced and sold, SMSLD would provide a price for the loan and ultimately it would be returned to the branch underwriter.[7]

The statement of facts also describes how Countrywide used more lax underwriting guidelines for due diligence reviews than for actually originating loans:

> In certain instances, Countrywide provided the due diligence providers with what were known as "Seller Loan Program Guides," which were guidelines based on the characteristics of loans that Countrywide had been able to make and sell in the past. Seller Loan Program Guides reflected the credit attributes of the loans that Countrywide had previously made and sold, and as a result they frequently listed lower credit scores or higher DTI and LTV ratios than the applicable Loan Program Guides or the applicable Shadow Guidelines.[8]

The B-of-A statement of facts is especially revealing on the subject of how Countrywide allowed underwriting exceptions. It describes that the firm essentially stopped bothering to weigh the sufficiency of compensating factors in approving requests for underwriting exceptions:

> On July 28, 2005, a Countrywide executive sent an email informing the SLD that it could begin to expand the programs for which it could approve "exception" loans to programs other than the 30 year fixed and 5/1 ARM loan products. He wrote:
>
> > [T]o the widest extent possible, we are going to start allowing exceptions on all requests, regardless of program, for all loans less than $3 million, effective immediately.
> > . . .
> >
> > The pricing methodology we will use will be similar to that which we use for 30-year fixed rates and 5-1 Hybrids. We will assume securitization in all cases.
>
> By June 7, 2006, less than a year later, an internal Countrywide email indicated that during May 2006, for prime loans, exceptions constituted by dollar amount approximately 30% of fundings for certain fixed loans, 40% for Pay-Option ARMs, and 50% for expanded criteria hybrid loans.[9]

[7] Settlement Agreement among the United States et al. and Bank of America Corporation et al., Annex 1, (August 18, 2014), p. 7, <http://www.justice.gov/iso/opa/resources/4312014829141220799708.pdf>.

[8] Ibid., p. 8. [9] Ibid., p. 10.

That is interesting material. But, things got even stranger in Countrywide's "Extreme Alt-A" program. In that program, the underwriters did not even have to *identify* compensating factors:

> In late 2006, Countrywide, after analyzing the mortgage products offered by certain of its competitors, implemented an expansion of its underwriting guidelines used by SLD underwriters, internally referred to as "Extreme Alt-A."
>
> . . .
>
> On April 5, 2006, a Countrywide executive sent an email regarding the Extreme Alt-A program that read, "[b]ecause this is a 'hazardous product' (direct quote from [another Countrywide executive]),... [that Countrywide executive] wants to see a detailed implementation plan which addresses the process for originating and selling these loans such that we are not left with credit risk." Countrywide began offering the Extreme Alt-A program in 2006 and began originating and selling loans under its expanded underwriting guidelines. As with most exception loans, the Extreme Alt-A guidelines called for Extreme Alt-A loans to be processed at the SLD level, but the Extreme Alt-A guidelines did not require SLD underwriters to identify compensating factors in connection with underwriting the loans.[10]

The whole statement of facts in the Bank of America settlement agreement is 30 pages long. In addition to the excerpts above concerning Countrywide, it contains interesting material about practices at Merrill Lynch and Bank of America (B-of-A) itself.

In early 2016, Morgan Stanley became the fourth major firm to enter into a settlement agreement with the DOJ. That settlement agreement also included a statement of facts detailing omissions and misstatements in the disclosure materials for the firm's private-label MBS deals.[11]

Deterioration of Origination Practices Was Probably Widespread

Of course, the sorts of behaviors described in the Justice Department settlement agreements with JP Morgan, Citi, B-of-A , and Morgan Stanley were happening at other firms as well. A number of cases have been adjudicated with findings that describe shoddy origination practices.[12] In addition, many other cases have been settled for sizable amounts. Table 19.1 lists a selection of such settlements (including the Justice Department settlements mentioned above). Each case involved allegations about the quality of loans included in MBS pools or allegations that disclosure about the quality of the loans was deficient.

[10] Ibid., p. 11 (emphasis added).

[11] Settlement Agreement between the United States and Morgan Stanley, Annex 1 (February 11, 2016), <https://www.justice.gov/opa/file/823671/download>.

[12] *Assured Guar. Mun. Corp. v. Flagstar Bank*, 920 F.Supp.2d 475 (S.D.N.Y. 2013) (bench trial resulting in a verdict for $105 million). *U.S. v. Countrywide Fin. Corp.*, No. 12-CV-1422, 2014 WL 3734122 (S.D.N.Y. July 30, 2014) (jury verdict followed by judge's determination of damages of $1.27 billion). *FHFA v. Nomura*, No. 11cv6201 (S.D.N.Y. May 11, 2015).

Table 19.1 Selected settlements involving claims relating to the issuance and sale of residential MBS or breaches of representations and warranties

Date	Amount ($ millions)	Defendant	Plaintiff
12/31/2010	1,520	Bank of America	Fannie Mae
12/31/2010	1,350	Bank of America	Freddie Mac
4/15/2011	1,100	Bank of America	Assured Guaranty
4/24/2012	280	Barclays	FHFA
4/27/2012	28	Option One	SEC
6/21/2012	40	Lehman Brothers	Local 302
3/21/2013	885	Credit Suisse	FHFA
4/2/2013	165	Bank of America	NCUA
5/28/2013	200	Citigroup	Allstate Ins.
5/28/2013	250	Citigroup	FHFA
6/21/2013	105	Flagstar Bancorp	Assured Guaranty[a]
7/25/2013	885	UBS	FHFA
10/17/2013	12	Deutsche Bank	NV Atty Gen'l
10/25/2013	5,100	JP Morgan Chase	FHFA
11/6/2013	335	Wells Fargo	FHFA
11/7/2013	154	RBS	SEC
11/15/2013	4,500	JP Morgan Chase	private MBS investors
11/19/2013	9,000	JP Morgan Chase	DOJ & various states[b]
12/2/2013	404	Bank of America	Freddie Mac
12/20/2013	1,925	Deutsche Bank	FHFA
12/31/2013	475	Ally Financial	FHFA
1/7/2014	10,000	Bank of America	Fannie Mae
1/6/2014	undisclosed	Goldman Sachs	Prudential Insurance
1/31/2014	8,500	Bank of America	various MBS investors
2/7/2014	1,250	Morgan Stanley	FHFA
2/24/2014	275	RBS	NJ Carpenters Health Fund
2/24/2014	undisclosed	JP Morgan Chase	Syncora Guarantee
2/27/2014	122	Société Générale	FHFA
3/21/2014	885	Credit Suisse	FHFA
3/26/2014	9,300	Bank of America	FHFA
4/21/2014	undisclosed	UBS	Union Central Life Ins.
4/24/2014	280	Barclays	FHFA
4/29/2014	110	First Horizon	FHFA
6/19/2014	100	RBS	FHFA
7/14/2014	7,000	Citigroup	DOJ & various states
7/24/2014	275	Morgan Stanley	SEC
7/31/2014	285	Citigroup	SEC
8/14/2014	undisclosed	RBS	Assured Guaranty
8/21/2014	16,650	Bank of America	DOJ & various states
8/22/2014	3,150	Goldman Sachs	FHFA
8/28/2014	undisclosed	Bank of America	National Integrity Life Ins.
9/8/2014	95	Morgan Stanley	pension funds
9/12/2014	550	HSBC	FHFA

(*continued*)

Table 19.1 Continued

Date	Amount ($ millions)	Defendant	Plaintiff
11/17/2014	undisclosed	Bank of America	FDIC
11/12/2014	undisclosed	Citi	Schwab
12/18/2014	95	Morgan Stanley	class action
1/15/2015	459	various banks	FHLB San Francisco
2/1/2015	500	JP Morgan Chase	retirement funds
2/6/2015	undisclosed	Goldman Sachs	life insurers
2/13/2015	235	Citigroup, Goldman Sachs, UBS	NJ Carpenters Health Fund
2/25/2015	2,600	Morgan Stanley	DOJ
3/26/2015	undisclosed	UBS	Capital Ventures Int'l
4/2/2015	undisclosed	Bank of America	BNP Paribas
4/27/2015	undisclosed	Bank of America	Prudential Securities
5/16/2015	806	Nomura	FHFA
6/26/2015	undisclosed	JPMorgan	Schwab
7/17/2015	388	JPMorgan	class action
8/13/2015	undisclosed	HSBC	Schwab
8/13/2015	272	Goldman Sachs	union pension funds
8/14/2015	undisclosed	Deutsche Bank	Mass Mutual
9/22/2015	undisclosed	Deutsche Bank	FHLB Des Moines
9/30/2015	undisclosed	Credit Suisse	Schwab
10/27/2015	325	Barclays	NCUA
10/27/2015	53	Wachovia Cap. Mkts.	NCUA
11/2/2015	undisclosed	First Tennessee Bank	Schwab
12/15/2015	undisclosed	Bank of America	Schwab
12/18/2015	225	Morgan Stanley	NCUA
1/14/2016	5,060	Goldman Sachs	DOJ
1/22/2016	63	various banks	Virginia
1/25/2016	995	JP Morgan Chase	Ambac
1/29/2016	63	Morgan Stanley	FDIC
2/11/2016	3,200	Morgan Stanley	DOJ and states[c]

Notes:

[a] Settled at the appeal stage after a decision at trial.

[b] Reported as $13 billion but included $4 billion of previously announced settlement with the FHFA.

[c] Reported as $3.2 billion but includes $2.6 billion of previously announced settlement with DOJ.

The settled cases give only a partial picture of how widespread shoddy origination practices had become. Other similar lawsuits are ongoing as of early 2016. Many others have been dismissed or were never filed because the injured investors failed to bring their claims before the statute of limitations had expired. In other instances, investors never brought suit because the issuers simply disappeared and did not survive to be defendants. Examples include Ameriquest, New Century, Option One, Fremont, and WMC. These five lenders alone originated more than $600 billion of subprime mortgage loans from 2004 through 2007 (see Table 19.2).

Table 19.2 Annual subprime mortgage loan production of the most active subprime lenders ($ billions)

Subprime Lender	2004	2005	2006	2007	Total
Ameriquest	82.70	75.56	29.50	6.40	194.16
HSBC	33.49	58.61	52.80	17.99	162.89
New Century	42.20	52.70	51.60	4.70	151.20
Countrywide	39.44	44.64	40.60	16.99	141.67
Option One	26.00	40.33	28.79	11.18	106.30
Citi	23.54	20.51	38.04	19.70	101.79
First Franklin	28.94	29.33	27.67	13.48	99.42
Washington Mutual	30.04	33.90	26.60	5.50	96.04
Wells Fargo	22.40	30.34	27.87	15.42	96.03
Fremont	23.91	36.24	32.30	n/a	92.45
WMC	13.30	31.80	33.16	5.00	83.26
GMAC-RFC	20.34	25.26	30.56	4.24	80.40
Aegis	11.90	17.84	17.00	4.30	51.04
Accredited	12.42	16.58	15.77	4.00	48.77
BNC	11.14	15.00	13.70	6.10	45.94
Chase	9.59	9.65	11.55	11.52	42.31
American General	4.60	15.43	15.07	4.50	39.60
Equifirst	6.20	8.84	10.75	4.35	30.14
Decision One	12.59	16.87	n/a	n/a	29.46
NovaStar	8.42	9.28	10.23	n/a	27.93
Ownit Mortgage	3.67	8.29	9.50	n/a	21.46
Fieldstone Mortgage	6.19	7.53	4.99	n/a	18.71
Finance America	8.28	10.30	n/a	n/a	18.58
EMC	n/a	n/a	9.49	7.91	17.40
ECC Capital	9.11	1.40	5.48	n/a	15.99

Source: Inside Mortgage Finance MBS database, Inside Mortgage Finance publications

The Effect on Mortgage Loan Origination Volumes

An important consequence of the deterioration of loan origination practices was that loan origination volumes remained very high following their cyclical peak in 2003 (see Figure 19.5).

The rise in loan origination volumes during 2001–3 is probably best explained by the low interest rates following the bursting of the tech bubble. However, after a record year of almost $4 trillion of loan originations in 2003, the annual production volume hovered in the neighborhood of $3 trillion for the next three years despite the fact that the Federal Reserve was tightening monetary policy. Production volume remained quite high in 2007 at roughly $2.5 trillion, even though the effective Fed Funds rate had reached its cyclical high by the start of that year.

The high level of mortgage loan originations from 2002 through 2006 caused further effects. First, it significantly boosted the volume of residential MBS issuance

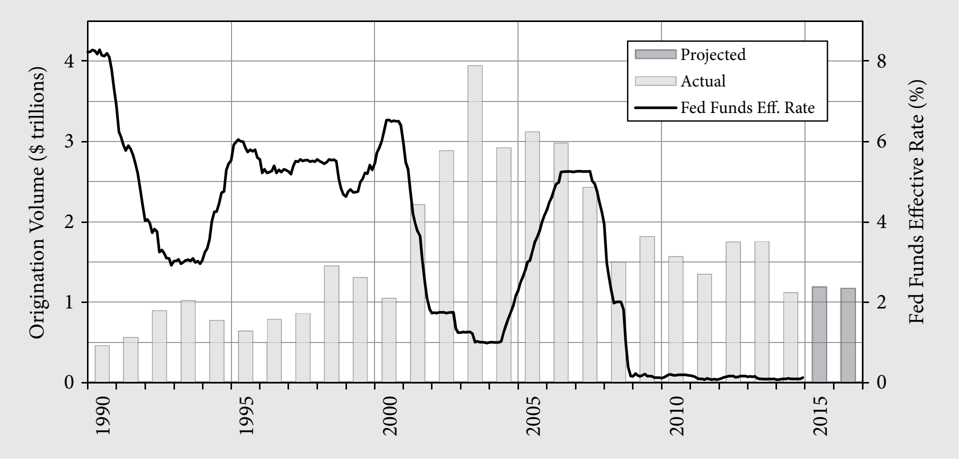

FIGURE 19.5 US residential mortgage loan origination volume

Source: Inside Mortgage Finance (1990–2011); Mortgage Bankers Association (2012–14 and projections); Federal Reserve

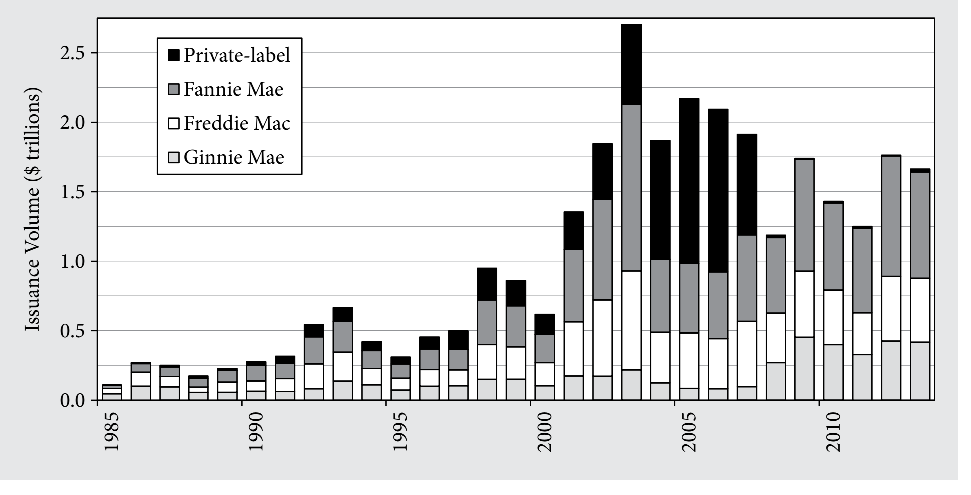

FIGURE 19.6 Residential MBS issuance volume

Source: SIFMA; *Mortgage Market Statistical Annual 2007* (for private-label before 1996). Used with permission.

(see Figure 19.6). The fluctuations in the overall volume of residential MBS issuance closely tracked the changes in the volume of loan originations. However, the composition of the overall issuance volume shifted notably toward private-label MBS. In fact, in both 2005 and 2006 the volume of private-label MBS issuance outpaced the combined issuance volumes of Fannie Mae, Freddie Mac, and Ginnie Mae (collectively, the "Agencies").

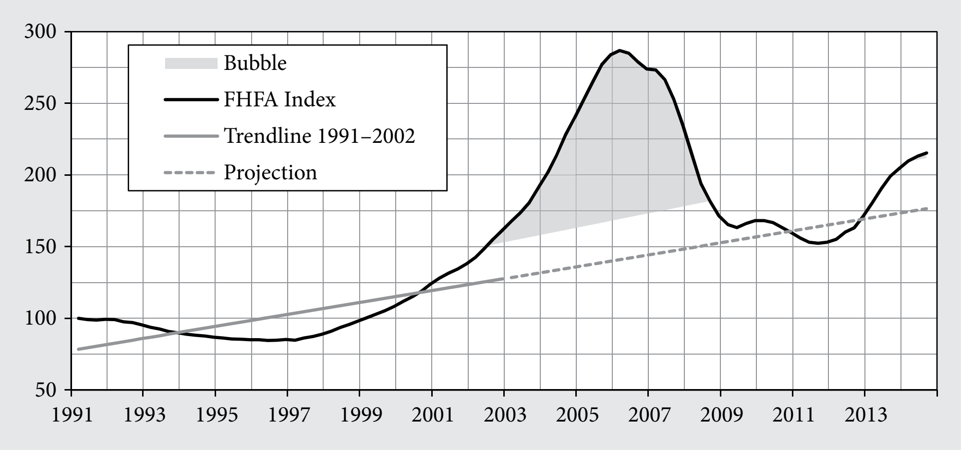

FIGURE 19.7 California home price appreciation, FHFA Index

Note: Purchase transactions only, seasonally adjusted. Bubble shown as index level more than 20% above long-term trend.

The shift toward private-label MBS issuance was a reflection of the market's willingness to accept deals with riskier loans that were ineligible for Fannie Mae, Freddie Mac, or Ginnie Mae programs. As noted above, SF-CDOs absorbed a large proportion of the subordinate tranches from private-label MBS issuance. In fact, the demand from SF-CDOs was so strong that the supply of subordinate MBS tranches could not keep up with demand. The market started creating "synthetic" subordinate tranches (i.e., credit default swaps that referenced actual MBS) to meet the strong demand from the SF-CDOs. The surging demand from the SF-CDOs was reflected in the tightening spreads on triple-B-rated tranches of MBS backed by subprime mortgages (see Figure 19.4).

Another effect of the surging loan origination volume was amplifying and sustaining the real estate bubble that was occurring in certain major markets (see Figures 19.7 and 19.8).

In retrospect, the bubble seems to have started in 2003 and may have initially been sparked by low interest rates. However, there can be little doubt that easy access to mortgage money in 2004–6 was a contributing factor that helped to drive home prices artificially higher.

According to some views, the bubble was national in its scope. However, the data gives only weak support to that position (see Figure 19.9).

The Outcome

Had the mid-2000s housing bubble never burst, continuing home price appreciation might have prevented weak loans from defaulting. A homeowner who could not afford

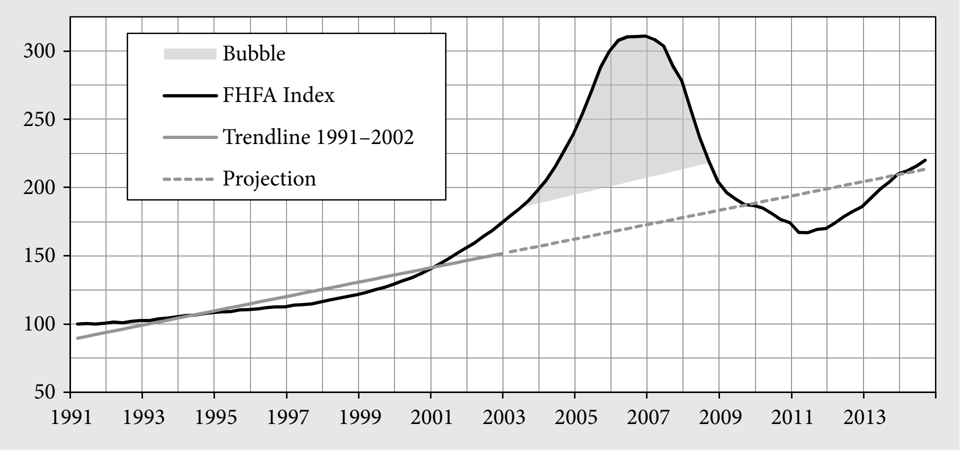

FIGURE 19.8 Florida home price appreciation, FHFA Index
Note: Purchase transactions only, seasonally adjusted. Bubble shown as index level more than 20% above long-term trend.

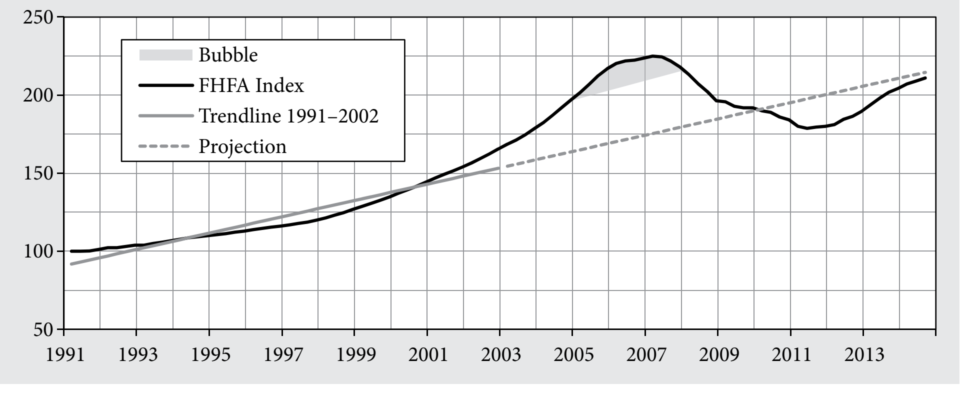

FIGURE 19.9 US home price appreciation, FHFA Index
Note: Purchase transactions only, seasonally adjusted. Bubble shown as index level more than 20% above long-term trend.

to make loan payments could simply have sold the mortgaged property for a price sufficient to cover the outstanding loan amount. With the bursting of the bubble, foreclosures started to increase (see Figure 19.10).

By November 2014, foreclosures had been completed on nearly 5.4 million residential mortgage loans since September 2008 (the month often identified as the start of the financial crisis).[13]

[13] CoreLogic, "Foreclosures—National Overview through March 2014," *CoreLogic National Foreclosure Report* (March 2014), 2. Sam Khater, "Ability-to-Leverage Drives Foreclosure Risk," *The MarketPulse* 4/1 (CoreLogic, January 2015), 8.

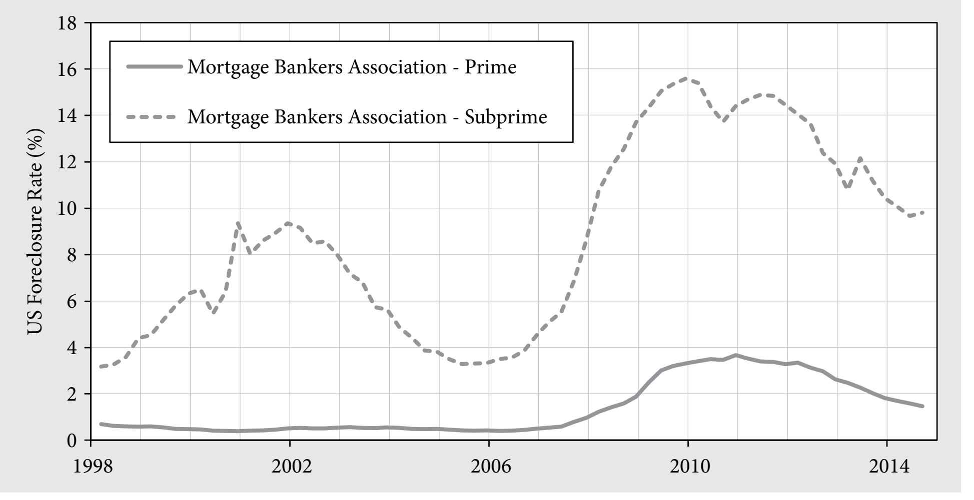

FIGURE 19.10 US foreclosure rate

Source: Mortgage Bankers Association

In addition to the 5.4 million foreclosures, millions of additional loans received modifications or terminated through short sales or deeds-in-lieu of foreclosure. From April 2009 through November 2014, more than 1.4 million loans had received permanent modifications under the federally sponsored "Home Affordable Modification Program" (HAMP).[14] During approximately the same period, another 4.3 million loans received modifications through lenders' "proprietary" programs (i.e., outside of HAMP).[15] On top of that, from September 2008 through October 2014, there were about 600,000 loan terminations through short sales and deeds-in-lieu of foreclosure for loans included in Fannie Mae or Freddie Mac programs.[16] Table 19.3 provides a summary.

The losses from foreclosures, loan modifications, and other distressed loan terminations were substantial. Particularly for loans originated during the peak of the bubble—from roughly mid-2005 through 2007—declining home prices caused loss severities to be much higher than for loans from earlier vintages.

The losses took several years to materialize. Delinquencies were on the rise before the bursting of the bubble, but they took time to mature into foreclosures and actual losses. As the volume of foreclosures grew, it strained the capacity of the existing infrastructure,

[14] Department of Housing and Urban Development, "The Obama Administration's Efforts to Stabilize the Housing Market and Help American Homeowners" (December 2014), 5. Department of Treasury, "Making Home Affordable—Program Performance Report through the Third Quarter of 2014" (December 2014), 8.

[15] Department of Housing and Urban Development, "The Obama Administration's Efforts to Stabilize the Housing Market and Help American Homeowners" (December 2014), 5. Hope Now Alliance, "Hope Now Data Report" (November 2014), 4–8, 10–11.

[16] Federal Housing Finance Agency, "Foreclosure Prevention Report" (October 2014), 4.

Table 19.3 Foreclosures, modifications, and distressed loan terminations

Item	Approx. No. (millions)	Interval	Main Sources
Foreclosures Completed	5.4	9/08–11/14	CoreLogic
HAMP Modifications	1.4	4/09–11/14	HUD, Treasury
Proprietary Modifications	4.3	4/09–10/14	HUD, Hope Now
Short Sales and Deeds-in-Lieu	0.6	4/08–10/14	FHFA
Total	11.7		

Table 19.4 S&P adverse credit migration rates of selected product subgroups of 2005–7 structured finance vintages

		Status as of December 31, 2010				
Product Subgroups	Original S&P Rating	Default + Near Default	Default	Near Default	Down-graded	No. of Ratings
US Residential MBS, CDOs of ABS, and SIV lites	AAA	60.1%	22.7%	37.4%	77.3%	4,043
	AA	78.2%	45.8%	32.4%	87.6%	8,340
	A	88.5%	59.7%	28.8%	93.4%	7,456
	BBB	94.0%	69.4%	24.7%	95.2%	7,806
	Inv. Grade	82.8%	52.8%	30.0%	89.8%	27,645
US Residential MBS (all)	AAA	56.4%	**18.8%**	37.6%	76.3%	3,430
	AA	78.2%	45.7%	32.5%	88.3%	7,625
	A	88.4%	61.9%	26.5%	93.6%	6,881
	BBB	93.9%	72.3%	21.6%	95.2%	7,142
	Inv. Grade	82.5%	54.0%	28.5%	90.1%	25,078
US Residential MBS (subprime only)	AAA	36.5%	**1.4%**	35.1%	63.0%	1,049
	AA	67.0%	28.5%	38.6%	82.7%	3,571
	A	86.0%	54.1%	31.9%	94.9%	3,040
	BBB	96.8%	76.4%	20.4%	98.4%	3,006
	Inv. Grade	77.8%	46.6%	31.2%	88.7%	10,666

Note: "AAA" ratings from the same transaction are treated as a single rating in this table's calculation. Multiple rating actions are aggregated to calculate a security's cumulative rating performance. Near default means rated "CCC+" or lower.

Source: Erkan Erturk, "Global Structured Finance Securities End 2010 with Rising Credit Stability," Standard & Poor's (February 7, 2011), tables 6a to 6c.

causing substantial delays. In addition, the mortgage servicing industry shot itself in the foot with fraudulent practices such as "robo-signing," which led to investigations, lawsuits, and several voluntary moratoria on foreclosures. By the end of 2010, the amount of losses was enough to have caused a significant number of private-label MBS to have defaulted. As shown in Table 19.4, S&P reported that defaults had occurred on 18.8% of the "AAA"-rated, private-label MBS from the 2005–7 vintages. Interestingly, the rating agency reported that the default rate was actually lower for "AAA"-rated securities backed by subprime loans.

After its report through year-end 2010, S&P stopped publishing updates on the performance of the 2005–7 private-label MBS vintages. Further updates would have been interesting because, as shown in Table 19.4, a large proportion of the securities were in "near default" status. It is likely that many of them subsequently did default.

Moody's presented performance statistics somewhat differently from S&P. From one perspective, the Moody's statistics are more revealing because they report separately for MBS backed by different types of loans: (1) prime-quality jumbo loans, (2) Alt-A loans, including option ARMS, and (3) subprime loans. Also, the Moody's statistics cover several additional years of deterioration and defaults. However, the Moody's statistics do not isolate the most troubled vintages. As shown in Table 19.5, Moody's reported a ten-year cumulative "impairment" rate of 44.7% for "AAA"-rated MBS backed by Alt-A or option ARM loans. Moody's reported corresponding figures of 18.5% for securities backed by subprime loans and 10.1% for securities backed by prime-quality, jumbo loans.

Table 19.5 Moody's multi-year cumulative impairment rates by original rating (2000 and later vintages)

Product Subgroups	Original Moody's Rating	Years (as of December 31, 2013)					
		5	6	7	8	9	10
US Jumbo Residential MBS	Aaa	3.1%	6.6%	9.1%	10.0%	10.1%	**10.1%**
	Aa	22.7%	23.6%	26.1%	27.3%	28.1%	28.1%
	A	15.1%	16.5%	27.4%	38.5%	43.2%	46.9%
	Baa	18.3%	22.0%	33.5%	49.7%	58.2%	60.6%
	IG	6.6%	9.7%	13.0%	15.2%	16.2%	16.7%
US Alt-A/ Option ARM Residential MBS	Aaa	29.4%	36.5%	41.2%	44.2%	44.6%	**44.7%**
	Aa	73.6%	78.0%	82.4%	83.9%	84.5%	85.2%
	A	76.1%	79.4%	87.4%	89.4%	90.8%	91.6%
	Baa	82.4%	84.7%	90.4%	92.4%	93.4%	94.0%
	Inv. Grade	45.2%	51.1%	56.5%	59.2%	59.9%	60.3%
US Subprime Residential MBS	Aaa	14.7%	16.0%	17.5%	18.0%	18.3%	**18.5%**
	Aa	49.2%	49.9%	50.9%	51.8%	52.5%	53.5%
	A	59.7%	63.1%	73.5%	78.9%	82.2%	84.0%
	Baa	70.1%	75.3%	87.3%	94.0%	95.4%	95.9%
	Inv. Grade	42.3%	45.0%	51.7%	55.8%	57.9%	59.0%

Note: Does not collapse tranches with the same rating from the same deal. "Impairment" includes default, downgrade to "Ca" or "C," and certain other events where an investor receives (or expects to receive with near certainty) less value than would be expected if the obligor or obligation were making payments.

Source: Debjani Dutta Roy, Kumar Kanthan, Albert Metz, and Nicolas Weill, "Default & Loss Rates of Structured Finance Securities: 1993–2013," Moody's (September 30, 2014), 33, 40.

So, as of this writing, the market still doesn't know the full amount of MBS losses attributable to the events and practices of 2005–7. It is probably fair to estimate that at least three quarters of the total had occurred by year-end 2014. However, it may take several more years for the full reckoning to be revealed.

Lessons from the Crisis

The experience of the financial crisis revealed a number of important lessons for the private-label MBS sector. As of mid-2015, the sector still had not recovered. Whether the sector can ultimately achieve a revival may depend on how well it absorbs the lessons from the crisis.

Loan Underwriting Needs to Be Systematic and Replicable

A lender's process for underwriting mortgage loans must focus on gauging the credit risk of a prospective loan and must do so in a systematic and replicable way. If underwriting is not systematic and replicable, investors cannot have confidence that lenders are actually following their underwriting guidelines or that reported loan attributes convey a meaningful reflection of risk. As described above, some lenders essentially abandoned real underwriting in the years before the crisis. The crisis showed that doing so is a clear recipe for trouble.

Although there is no universally accepted dictionary definition of mortgage underwriting, it is always primarily about credit. For example, *The Mortgage Encyclopedia* explains that loan underwriting involves verifying whatever information the borrower provides and "assessing information on the applicant's creditworthiness."[17] In a similar vein, long-standing federal regulations are clear that mortgage underwriting is about credit quality and requires an analysis of multiple factors. For example, federal banking regulators have had uniform standards for real estate lending since 1993. The uniform standards state that "[p]rudently underwritten real estate loans should reflect all relevant credit factors. . . ."[18]

The customs and usages of the mortgage industry confirm the notion of what it means to underwrite a residential mortgage loan. Fannie Mae's *Single Family 2002 Selling Guide* explains that the purpose of underwriting mortgage loans is always to assess the credit risk of a mortgage loan, even for a loan originated through programs that allow for risky loans.[19] Likewise, Freddie Mac's *Single Family Seller Servicer Guide* states that underwriting is a process of credit review that considers multiple factors.[20] The selling guides of

[17] Jack Guttentag, *The Mortgage Encyclopedia: The Authoritative Guide to Mortgage Programs, Practices, Prices and Pitfalls*, 2nd edn (New York: McGraw-Hill, 2010), 327.

[18] 12 C.F.R. Part 208, Subpt. D, App. C (2013), announced in Federal Reserve Supervisory Letter SR 93-1 (January 11, 1993), <http://www.federalreserve.gov/boarddocs/srletters/1993/SR9301.htm>.

[19] Fannie Mae, *Single Family 2002 Selling Guide*, Part X, Introduction (June 30, 2002).

[20] Freddie Mac, *Single-Family Seller/Servicer Guide*, vol. 1, ch. 37.1 (January 1, 2013).

both Fannie Mae and Freddie Mac include separate chapters addressing the issues of fraud and the accuracy of information used to make a lending decision. Although that material is not included in the introductory language of the respective chapters on underwriting, it is inherent in the idea of underwriting. The notions of screening for fraud and reasonably assuring the accuracy of information cannot be divorced from underwriting.

The "Three Cs" of Mortgage Credit Really Matter

In analyzing credit, a lender's underwriting process must focus on the "Three Cs": (1) credit reputation, (2) capacity, and (3) collateral. Credit reputation refers to a borrower's past payment behavior in paying his debts. A borrower who has a strong track record of paying debts on time is a lesser risk than one with a checkered history. Today, a borrower's credit reputation is often summarized in a computerized score, such as a FICO® score. Capacity refers to a borrower's ability to make payments. Capacity can come from either assets or income, but income is the more common source. The customary measures of capacity are a borrower's debt-to-income ratio or DTI (i.e., the ratio of monthly debt payments to monthly income) and reserves (i.e., the ratio of the borrower's liquid assets to the monthly payment on the loan). Collateral refers to the property that secures a mortgage loan. Foreclosure and sale of the property provides an alternative source of repayment in case the borrower defaults. The degree of coverage provided by collateral is typically measured by a loan-to-value ratio or LTV (i.e., the ratio of the amount of a loan to the lesser of the appraised value or the purchase price of the home).[21]

Many of the mortgage loans that defaulted during the financial crisis were originated through lending programs that ignored one or more of the Three Cs. For example, some loan programs allowed borrowers to bypass documenting their income and assets. Some lenders accepted exaggerated incomes because doing so allowed them to make more loans. So-called "no-income, no-asset" programs allowed borrowers to get loans without disclosing (or making any statement at all) about their income or assets. In retrospect, it appears that in originating loans under such programs, lenders may have ignored the issue of repayment capacity altogether. As a result, Congress has imposed a legal requirement on lenders to make a "reasonable and good faith determination based on verified and documented information that, at the time the loan is consummated, the consumer has a reasonable ability to repay the loan."[22] Lenders can satisfy that requirement on many loans without actually determining a borrower's ability to repay, but lenders must verify and document the income and financial resources relied upon to qualify a loan.

How a Lender Handles "Risk Layering" Is Important

A lender's loan underwriting process must address "risk layering." Risk layering refers to the presence of multiple weak attributes in a single loan. The impact of risk layering

[21] Ibid.; Freddie Mac, "The 3 Cs of Underwriting Factors Used in Loan Prospector's Assessment," <http://www.freddiemac.com/corporate/au-works/factors.html>.

[22] Dodd-Frank Wall Street Reform and Consumer Protection Act § 1411, Pub. L. No. 111-203, 124 Stat 1376 (2010) (codified at 15 U.S.C. § 1639(a)).

tends to be multiplicative rather than merely additive. Thus, in properly underwriting a loan, a lender should make sure not only that each of the Three Cs is acceptable, but also that the overall layering of risk is acceptable. An approval decision should not be based on overemphasizing any one of the Three Cs. Strength in one cannot offset weakness in the other two, but strength in two might offset weakness in the third. In addition, risk layering can cause a loan to be an unacceptable risk even when all Three Cs are acceptable. This can happen when other factors present layered risks (e.g., product type, occupancy status, property type).

A sound underwriting approach analyzes all risk factors present in a prospective loan. A sound approach avoids double-counting positive factors. For example, if an automated underwriting system uses LTV or FICO® score, then LTV or FICO® score cannot serve as offsetting factors to compensate for risk layering. In addition, a sound approach documents both identified risk factors and the offsetting factors that a lender relies on in deciding to approve a loan.[23]

Loan Underwriting "Exceptions" Can Be Handled Well or Poorly

A lender's loan underwriting process reasonably may allow for exceptions to its guidelines if a borrower can demonstrate "compensating factors." However, the experience of the financial crisis demonstrated that some lenders had ineffective processes for weighing the benefit of compensating factors against the risks associated with their corresponding exceptions. The issue of whether lenders allowed exceptions without sufficient compensating factors has become the subject of much litigation.

The idea of underwriting exceptions and compensating factors is well established and well accepted within the mortgage industry. In fact, even the guidelines of the GSEs provide for using compensating factors as a basis for concluding that a loan does not suffer from excessive risk. Thus, an applicant who just barely missed the cut-off on a key variable might be granted an exception based on qualitative factors (e.g., employment or housing stability) or on quantitative factors that the underwriting guidelines would not otherwise capture (e.g., extremely strong DTI or LTV in a manual system). Depending on the particulars of a lender's underwriting guidelines and its process (automated vs manual), the types of things that might be used as compensating factors include the following:

- length of time in current residence;
- length of time at current job;
- pending sale of mortgaged property (old home), which distorts DTI;
- very high level of liquid assets (not in automated systems);
- very high level of reserves (not in automated systems);
- very low DTI (not in automated systems);
- very low LTV (not in automated systems).

[23] Freddie Mac, *Single-Family Seller/Servicer Guide*, vol. 1, ch. 37.1(c) (January 1, 2013).

In a similar vein, a lender might reasonably treat derogatory information on an applicant's credit report differently depending on whether it was due to extenuating circumstances beyond the applicant's control (e.g., medical problems) or due to financial mismanagement.[24] Derogatory information arising from extenuating circumstances might cause an applicant's FICO® score to be misleadingly low and to give an unwarranted negative portrait of the applicant's true creditworthiness.

The other side of the coin is that underwriting exceptions should never be allowed for certain types of problems in a loan application. For example, there should be no compensating factors sufficient to counterbalance strong evidence of fraud by the applicant. Likewise, there should be no compensating factors sufficient to counterbalance an applicant's lack of legal capacity or a material, non-insurable defect in title to the property.

In all cases of underwriting exceptions, the compensating factor must be at least sufficient to counterbalance the added risk attributable to the exception. If not, the target risk tolerances embodied in the underwriting guidelines would be undermined.

The bottom line on mortgage loan underwriting is this: To say that "mortgage loans were originated in compliance with underwriting guidelines" means at least the following:

- the loan origination process includes an analysis of each loan's credit quality;
- the analysis of credit quality considers trade-offs between various risk factors such as the Three Cs and other relevant factors such as occupancy status, loan purpose, property type, number of units, and loan product type;
- corollary to the consideration of trade-offs, the process addresses the issue of risk layering;
- the process screens for fraud by applicants and mortgage brokers by considering the reasonableness and logical consistency of information provided; and
- the process includes reasonable steps to verify or otherwise reasonably assure the accuracy of information that forms the basis of the lending decision.

The foregoing items are inherent in the nature of underwriting. The process would not be "underwriting" if any of them were missing.

Housing Bubbles Happen and They Burst

A housing bubble can create a different and more challenging stress than ordinary economic fluctuations. While a bubble is inflating, and especially near its peak, loans originated with seemingly strong collateral coverage (i.e., low or moderate LTVs) may be riskier than they appear. Loans originated with higher LTVs may become extremely vulnerable once the bubble bursts or deflates. The bursting of the mid-2000s housing bubble and the ensuing declines in home values caused many loans to become "underwater."

[24] Freddie Mac, "Underwriting Reminders for Loan Prospector® Caution Risk Class Mortgages" (February 2014), <http://www.freddiemac.com/learn/pdfs/uw/caution_remind.pdf>.

An underwater loan is one where the loan amount exceeds the value of the mortgaged property.

While the bubble was inflating, lenders did not adjust their underwriting guidelines and the credit rating agencies did not adjust their analyses. Until lenders and rating agencies start to approach bubble situations proactively, investors need to protect themselves.

One approach would be to stop buying private-label MBS when home prices are more than 20% (or some other level) above their long-term trend. As shown in Figures 19.7 and 19.8, such a strategy would have sent a signal to stop buying private-label MBS sometime in 2003. Using a higher trigger level of 40% would have produced a signal to stop buying in 2004. Either way, the investor can avoid the bubble-related issues and still earn a return on convexity (i.e., prepayment risk) by shifting to agency MBS.

The mid-2000s housing bubble was not America's first housing bubble. Since the 1970s, the country has had some notable regional and local bubbles. For example:

- Houston home prices peaked in 1983 Q2 before starting a five-year slide in which they declined by roughly 25%. It was not until 1998 that Houston home prices recovered to the level at which they had been in 1983.
- Home prices in the Los Angeles area peaked in 1990 Q3. Then they declined for six years, reaching a level 21.5% below their peak. They recovered to their 1990 levels in 2000.
- Honolulu home prices peaked around the end of 1995. They dropped 16.7% over the next four years. They turned around at the end of 1999 and made it back to their prior high around the end of 2002.

Property appraisal practices evolved slightly after the bursting of the mid-2000s housing bubble. In 2008, Fannie Mae introduced Form 1004MC, which is a "Market Conditions Addendum" to a standard home appraisal. The addendum "is intended to provide the lender with a clear and accurate understanding of the market trends and conditions prevalent in the subject neighborhood." However, it is not clear that either lenders or the GSEs intend to use the addendum to capture evidence of emerging bubbles for the purpose of proactively revising underwriting guidelines. That is unfortunate because, as the experience of the financial crisis shows, defensive positioning is warranted once bubble conditions appear.

Loan Modifications Have a High Re-default Rate

The strategy of modifying loans to mitigate ultimate losses has achieved only limited success. Too many modified loans re-default. The federal policy of promoting loan modifications was intended to mitigate hardship on borrowers and to reduce the magnitude of home price declines. However, the policy may have extended the effects of the crisis by delaying some markets from attaining natural equilibrium levels from which a recovery could commence. Allowing markets to have reached their natural bottom more quickly might have allowed the process of recovery to start sooner.

Table 19.6 Re-default rates for modified mortgage loans (60 or more days delinquent)

Investor Loan Type	6 Mos. after Mod.	12 Mos. after Mod.	18 Mos. after Mod.	24 Mos. after Mod.	36 Mos. after Mod.
Fannie Mae	16.2%	22.9%	26.0%	26.5%	25.7%
Freddie Mac	15.3%	21.5%	24.6%	25.5%	25.3%
Government-Guaranteed	28.0%	41.3%	46.3%	48.8%	50.9%
Private	28.4%	37.3%	41.5%	42.9%	43.8%
Portfolio Loans	12.7%	19.4%	22.6%	23.8%	25.3%
Overall	21.4%	29.9%	33.7%	35.0%	35.9%

Note: Includes all modifications made since January 1, 2008 that have aged the indicated number of months.

Source: OCC Mortgage Metrics Report, Fourth Quarter 2014, table 3

Table 19.6 shows the results for modified loans as reported by the OCC through 2014 Q4. As shown in the table, the three-year re-default rate for modified loans in private-label MBS was 43.8%.[25]

When the next housing bubble bursts, policymakers should be less eager to push for loan modifications. It might be better to deploy policies that have a chance of achieving a higher success rate.

Credit Ratings on Private-Label MBS May Be Unreliable

Credit ratings on private-label MBS performed very poorly through the crisis. The performance shown in Tables 19.4 and 19.5 was unimaginable until it actually happened. Some rating agencies updated their analytic methodologies in the wake of the financial crisis. However, it remains to be seen whether those changes are enough. Moreover, even if a rating agency made appropriate updates to its methodology, the updates may be reversed or replaced before the next bubble or other stress emerges.

As noted above, the rating agencies did not react sufficiently to bubble conditions while they were forming. However, that was probably not the only source of disappointing performance of their credit ratings. The rating agencies also misjudged the sensitivity of mortgage loan default rates to declining home prices. That is, declining home prices became a significant factor in why many borrowers defaulted.

In addition, the rating agencies underestimated the risk layering effects of certain combinations of loan attributes. For example, the experience of the financial crisis demonstrated that combining a high LTV and "stated income" (i.e., no verification of a

[25] Office of the Comptroller of the Currency, "OCC Mortgage Metrics Report, Third Quarter 2014" (December 2014), table 3.

borrower's income) in a single loan produced an unanticipated degree of risk. Loans with those attributes ended up performing much worse than originally expected.

The rating agencies also did not react quickly enough or strongly enough to the widespread deterioration of underwriting practices among mortgage lenders. The breakdown of underwriting practices caused the risk content of newly originated loans to increase dramatically. The rating agencies failed to pick up the threat until it was too late.

Lastly, there have been allegations that some rating agencies allowed their business interests to compromise their analytic objectivity. That is, they may have practiced "competitive laxity" in order to attract business from MBS issuers and investment bankers. At least one rating agency has entered into a substantial settlement (including certain admissions) with the Department of Justice and various states' attorneys general.[26]

Issuers and investment bankers would frequently select rating agencies to rate their MBS on the basis of which agencies would deliver the lowest credit enhancement levels for the proposed securities. In order to win the rating assignment for a given offering, a rating agency had to offer lower credit enhancement levels than its competitors. New SEC regulations provide that a rating agency must not allow "sales or marketing considerations" to influence its analysis and its rating conclusions.[27] However, the efficacy of those regulations is not yet proven and the incentive structure that encourages competitive laxity remains in place.

The Federal Securities Laws May Provide Little Protection to Private-Label MBS Investors

The federal securities laws may provide little protection to private-label MBS investors. In theory, the most powerful provision for an injured investor to use for recovering losses would be Section 12 under the Securities Act of 1933. That provision allows an injured investor to rescind the purchase of the securities. However, the short statute of limitations for cases under Section 12 has made it an ineffective tool for many private-label MBS investors.

The statute of limitations for Section 12 is generally the earlier of three years from the offer or sale of the subject security or one year after the discovery of the violation or untrue statement. For many investors who bought highly rated, senior tranches of MBS offerings, it took longer than three years for the performance of the underlying loans to deteriorate to the point where the securities would suffer losses. Thus, the investors did not realize that they should start a Section 12 lawsuit until the statute of limitations had already expired.

Of course, with the benefit of 20/20 hindsight, one might argue that investors should have filed their lawsuits at the first hint of performance deterioration. But that is not

[26] Settlement Agreement among the United States et al. and McGraw-Hill (February 2, 2015), <http://www.justice.gov/file/338701/download>.

[27] SEC Rule 17g-5(c)(8); Securities and Exchange Commission, *Nationally Recognized Statistical Rating Organizations*, Release No. 34-72936, 79 Fed. Reg. 55078, 55264 (September 15, 2014).

realistic, especially with respect to the investors who bought highly rated, senior tranches. The defining feature of those tranches is that they are (ostensibly) designed to withstand substantial performance deterioration of their underlying loans and still not suffer losses. Even though the performance deterioration was starting to emerge in 2007 (see Figure 19.10), the impact on senior tranches did not become apparent until years later.

Other provisions of the federal securities laws are less useful for private-label MBS investors who suffered losses. Bringing a successful lawsuit under those other provisions may be less effective because they provide for limited damages rather than rescission of the sale. In addition, some of the other provisions require difficult elements of proof, such as intent to defraud ("scienter" in legal terminology).

The upshot is that in the wake of the financial crisis, investors who brought lawsuits often did not base their claims on the federal securities laws. Instead, they based their claims on either state "blue sky" laws or common-law principles such as fraud or breach of contract. An important exception, however, was the FHFA. The FHFA successfully pursued claims under the federal securities laws against many defendants (see Table 19.1). Unlike other investors, the FHFA has the benefit of a special statute of limitations (12 U.S.C. § 4617(b)(12)) that gives it more time to start legal proceedings.

Lengthening the limitations period for claims under Section 12 would allow the federal securities law to provide meaningful protection to private investors in private-label MBS. However, until Congress takes up that issue, the federal securities laws are not likely to provide investors with a effective means of recovering compensation for defective securities.

Representations and Warranties Have Been an Important Source of Protection for Investors, But that Could Change

Contractual representations and warranties about the attributes of securitized mortgage loans were a key source of protection for investors in private-label MBS from the crisis period. Those representations and warranties were at the center of the breach of contract lawsuits mentioned in the previous section. When the loans underlying a deal did not comply with the deal's representations and warranties, investors (often acting through the deal's trustee) could compel the issuer to repurchase the loans. The lawsuits came to be known as "put-back" cases because the investors were "putting the loans back" to the issuer.

The widespread success of put-back cases has produced a backlash from issuers. They have started a movement to introduce "sunset provisions" or expiration dates on representations and warranties. The rationale is that after a loan has performed according to its terms for a number of years, any defects that existed at the inception of the deal have become irrelevant. Many investors take a contrary view.[28]

[28] Structured Finance Industry Group, "RMBS 3.0—A Comprehensive Set of Proposed Industry Standards to Promote Growth in the Private Label Securities Market," 2nd edn (November 10, 2014), 115.

A key function of the representations and warranties is to reduce or eliminate the need for in-depth reviews of each loan to be included in a deal prior to its inception. Representations and warranties that persist for the life of a deal allow the original execution of the deal to be much more efficient. Pre-closing due diligence can be performed on a sampling basis to test the accuracy of disclosures and, potentially, to determine the overall frequency of defective loans. It has not traditionally been necessary to examine all loans before closing. Investors have been willing to accept the risk of unidentified defective loans (i.e., those that reach representations and warranties) partly because persisting representations and warranties give them the chance to put defective loans back at a later date.

The occurrence of mortgage loan defaults depends partly on fluctuations in economic conditions such as housing bubbles. Certain defects may have no effect during benign economic conditions (e.g., during periods of rising home prices). However, when conditions change, their effects appear. In a deal with persisting representations and warranties, defaulted loans that are defective would be put back to the issuer. Those that are not defective would remain in a deal and any associated loss would be allocated in accordance with the deal's terms. The only loans that would ever need to be reviewed for defects are those that default. This keeps the cost of loan reviews—and the cost of doing deals—low enough to be economical.

Without persisting protection from representations and warranties, investors may demand in-depth reviews of all the loans in a deal before its closing. The cost of those reviews may make private-label MBS deals uneconomical for issuers.

Separately, the protections from representations and warranties may be reduced by court rulings regarding the statute of limitations. New York's highest court has ruled that representations and warranties in a contract governed by New York law expire six years after the signing of the contract.[29]

Governance and Conflicts of Interest Are Real Issues in Private-Label MBS

Before the financial crisis, it was common for market participants to describe private-label MBS structures (and other securitization structures) as "brain-dead," meaning that all possible actions were preprogramed at a transaction's inception. The experience of the crisis showed that the idea of a truly brain-dead structure was illusory. Conflicts of interest emerged and revealed the need for private-label MBS transactions to include mechanisms for addressing such conflicts and, more broadly, for general governance in unforeseen circumstances.

One type of conflict of interest that emerged was between a deal's servicer and its investors. The servicer may be able to maximize the fees that it receives by taking actions that are not in the best interests of investors. This became a particular problem when the federal government promoted certain types of loan modification by offering incentive

[29] *ACE Securities v. DB Structured Products*, 25 N.Y. 3d 581 (2015).

fees to servicers. Another type of conflict that emerged was between different classes of investors holding securities at different seniority levels. Holders of senior classes would typically view loan modifications less favorably than holders of subordinate classes. Loan modifications delay the realization of losses and may allow holders of subordinate classes to receive more cash flow. Even years after the crisis, those conflicts continued to plague outstanding deals from the bubble era.[30]

Disclosure Standards and Offering Procedures Are Changing, But the Effect on Investor Protection Remains Uncertain

Even before the financial crisis, there were occasional grumblings from investors about both disclosure practices and the offering process for private-label MBS. The financial crisis cast the issues in sharp relief and prompted action by the SEC. The SEC released a major package of new regulations on August 27, 2014.[31]

Among other things, the new rules call for loan-level disclosure about the mortgage loans underlying private-label MBS (starting in November 2016). They change the timing of private-label MBS offerings to give investors more time to review a deal's offering materials before deciding whether to invest. The rules also require the use of a single prospectus, eliminating the use of two-part prospectuses that had been the norm for three decades. In addition, they establish a new eligibility framework for using the streamlined "shelf registration" process, and they improve the quality of monthly reporting over the life of new private-label MBS transactions.

It will take at least several years to tell whether the new disclosure standards and offering procedures actually improve investor protection in the private-label MBS area. The real test will come only when the next significant housing bubble bursts. In the meantime, the rigor and detail of the new rules will likely increase the cost of doing deals. They may have the unintended effect of discouraging lenders from issuing private-label MBS and, consequently, from originating nonconforming loans. That would be a shame because one of the objectives of the rules was to help achieve a revival of the private-label MBS sector.

Key Points

- The financial crisis had strong effects on the US economy. Unemployment rose briefly to 10% and output contracted significantly in 2009. Household net worth temporarily declined by more than $10 trillion.
- Mortgage loan origination practices deteriorated markedly in the years leading up to the

[30] Katherine Burton and Jody Shenn, "Pimco and Hedge Funds Are Still Fighting Over Subprime Scraps," *Bloomberg News* (May 26, 2015).

[31] SEC, *Asset-Backed Securities Disclosure and Registration*, Release Nos. 33-9638, 34-72982, 79 Fed. Reg. 57184 (September 24, 2014).

financial crisis. Underwriting guidelines became increasingly lax. However, a far bigger issue was the failure by many lenders to even follow their guidelines.

- The deterioration of origination practices helped mortgage loan origination volumes remain high following their cyclical peak in 2003. Structured finance CDOs became major buyers of the subordinate tranches of private-label MBS starting in 2004, and strongly influenced how the capital markets mispriced mortgage credit risk. The SF-CDOs essentially pushed other subordinate tranche buyers to the sidelines, which precipitated a breakdown of discipline that the MBS market had provided for the loan origination sector. That, in turn, reinforced the trend toward riskier and riskier loans.
- The deterioration of origination practices, combined with easy funding from the issuance of private-label MBS, helped fuel housing bubbles in certain key markets, such as California and Florida. According to some views, the bubble was national in scope.
- After the housing bubble burst, millions of loans defaulted. About 5.4 million foreclosures had been completed as of November 2014. Millions of other defaulted loans were resolved though loan modifications or short-sales.
- Defaults on private-label MBS were widespread. Even securities that had initially received triple-A credit ratings defaulted in huge numbers.
- The events of the crisis revealed that mortgage loan underwriting must be systematic and replicable. It must focus on credit. It must consider the “Three Cs.” It must address risk layering and have a rigorous process for handling exceptions. It must make sure that reliable information feeds the underwriting process.
- The crisis served as a painful reminder that the normal way a housing bubble ends is by bursting. Other ends are possible (e.g., gradual deflation), but bursting is the norm.
- Loan modifications may not be a highly effective way of helping borrowers to keep their home. The re-default rate on modified loans has been high.
- Credit ratings on private-label MBS may not be reliable indicators of risk. The experience of the financial crisis shows that the rating agencies don’t have any magic formula for gauging the riskiness of the securities. New SEC regulations attempt to address some of the perceived shortcomings in how rating agencies operate, but the efficacy of those regulations will not be proven for some time.
- The federal securities laws did not provide a high level of protection for investors in private-label MBS. Instead, investors received more protection from their contractual rights and from state “blue sky” laws.
- Governance and conflicts of interest are real issues in private-label MBS because they are not simply “brain-dead” structures.
- Disclosure standards and offering practices for new private-label MBS offerings will be different from what they were before the crisis. However, it remains to be seen whether the changes will improve investor protection.

CHAPTER 20

CREDIT ENHANCEMENT

FRANK J. FABOZZI AND BILL BERLINER

After reading this chapter you will understand:

- why private-label mortgage securities must be structured with credit support;
- the role of credit rating agencies in private-label transactions;
- the three forms of credit enhancement used for private-label mortgage securities: (1) structural, (2) originator/seller-provided, and (3) third-party-provided;
- why certain interest rate derivative instruments can be used as a form of credit enhancement;
- some changes in credit support structures that have come into play after the financial crisis of 2007–8.

The investor in private-label (i.e., non-agency) mortgage securities products is exposed to credit risk. The absence of any government guarantee means that for the senior tranches to obtain an investment-grade rating, private-label mortgage securities must be structured with additional credit support to absorb expected losses from the underlying loan pool due to defaults. This additional credit support is referred to as credit enhancement. There are different credit enhancement mechanisms available to issuers. In addition, derivative instruments, specifically interest rate swaps and interest rate caps, can be used as a form of credit enhancement. The credit enhancement mechanism(s) utilized are those that provide the issuer with the best execution. That is, the techniques used will maximize proceeds from the sales of the pool of mortgage loans after credit enhancement expenses (implicit and explicit) are taken into account.

In assigning a credit rating to a bond class in a private-label transaction, the credit rating agencies will determine the amount of credit enhancement needed to obtain the issuer's target credit rating. The amount will be based on the credit quality of the borrowers in the pool and other factors such as the structure of the transaction. The process by which the credit rating agencies determine the amount of credit enhancement needed to obtain a specific credit rating is referred to as sizing the transaction.

In this chapter we describe the three forms of credit enhancement used for private-label mortgage securities: (1) structural, (2) originator/seller-provided, and (3) third-party-provided. We also explain how derivatives such as caps and swaps are being utilized as credit enhancement. At this writing, the secondary market for private-label mortgage securities is dominated by bond classes from pre-2007 deals. Consequently, an investor must understand the credit enhancement structures in these pre-2007 deals in order to make prudent investment decisions. Since the mortgage and MBS markets have changed since the subprime mortgage crisis in 2007, we conclude this chapter with a discussion of some of the major changes in credit enhancement structures and mechanisms.

Structural Credit Enhancement

Structural credit enhancement refers to the redistribution of credit risks among the bond classes included in the structure so as to provide credit enhancement by one bond class to one or more of the other bond classes in the structure. To accomplish this, the bond classes in the structure (i.e., the capital structure) are given different priorities on the mortgage pool's cash flow. The capital structure includes two general categories of bond classes: senior bond classes and subordinated bond classes. The resulting structure, which is common in all private-label mortgage transactions, is called a senior-subordinated structure.

It is worthwhile to compare the capital structure for a corporation and a private-label mortgage transaction. In a corporate structure, the senior secured debt has a prior claim over unsecured debt, while the latter has a prior claim over subordinated debt, preferred stock, and equity. However, it is well known that in a corporate bankruptcy under Chapter 11 of the US Bankruptcy Code, the priority of creditors is typically violated. This is not the case in a private-label mortgage security structure, because the priority rules are strictly enforced for the capital structure.

The bond class or classes in the capital structure with the highest credit rating are referred to as the senior bond classes. The subordinated bond classes in the capital structure are those below (i.e., more junior to) the senior bonds. The rules for the distribution of the cash flow (interest and principal) among the bond classes, as well as how losses are to be distributed, are explained in the supplementary prospectus. The rules, commonly referred to as the cash flow waterfall, or simply the waterfall, set forth how the deal's cash flows and losses are to be distributed amongst the bond classes. The distribution of losses is based on the position of the bond class in the capital structure. Losses are allocated starting from the bottom (the lowest or unrated bond class) and progress to the senior bond class.

Let's compare what is being done in a private-label mortgage structure with what is done in an agency CMO. In an agency CMO, there is no credit risk for Ginnie

Mae-issued structures, and the credit risk of the loan pool for Fannie Mae- and Freddie Mac-issued structures has been viewed until recent years as small. In addition to creating bonds that meet the specific investment objectives of different investor clienteles, what is being done in creating the different bond classes in an agency CMO is the redistribution of prepayment risk. In contrast, in a private-label mortgage deal, there is both prepayment risk and credit risk. By creating the senior-subordinated bond classes, credit risk is being redistributed among the bond classes in the structure. Hence, what is being done is called credit tranching.

Let's look at an actual transaction at the time of issuance. Table 20.1 shows the offered bond classes for the J.P. Morgan Mortgage Trust 2005-A4 and the *original* credit ratings.[1] There were 12 bond classes offered, nine of which were senior bond classes; there were also three subordinate tranches that were not offered as part of the original underwriting. (Lower-rated subordinates are typically offered separately from the senior and investment-grade subordinates or, at the issuer's option, are retained for investment purposes.) At issuance, the senior bonds were rated AAA. The three offered subordinate classes were rated AA, A, and BBB, which are "investment-grade" ratings, while the lower-rated (and non-offered) subordinates were rated BB and B, along with an unrated first-loss piece. (Bonds rated below BBB are considered below investment grade.) The waterfall allocates cash flows received by the trust first to the senior bonds

Table 20.1 J.P. Morgan Mortgage Trust 2005-A4: Offered bond classes and original credit ratings

Class	Initial Class Principal Amount	Designation	S&P Rating	Dbrs Rating	Moody's Rating
Class 1-A-1	$265,645,300	Senior	AAA	AAA	Aaa
Class 2-A-1	$205,319,200	Senior	AAA	AAA	Aaa
Class 3-A-1	$100,000,000	Senior	AAA	AAA	Aaa
Class 3-A-2	$49,321,600	Senior/Sequential	AAA	AAA	Aaa
Class 3-A-3	$45,986,000	Senior/Sequential	AAA	AAA	Aaa
Class 3-A-4	$22,280,800	Senior/Sequential	AAA	AAA	Aaa
Class 4-A-1	$167,264,850	Senior/Sequential	AAA	AAA	Aaa
Class 4-A-2	$50,244,350	Senior/Sequential	AAA	AAA	Aaa
Class A-R	$100	Senior/Residual	AAA	AAA	Aaa
Class B-1	$12,695,300	Subordinate	AA	AA	Aa2
Class B-2	$8,463,400	Subordinate	A	A	A2
Class B-3	$5,172,300	Subordinate	BBB	BBB	Baa2

[1] <http://www.sec.gov/Archives/edgar/data/1085309/000095013605003854/file001.htm>. There were also non-offered subordinate bond classes: Class B-4 ($3,761,500 rated BB), Class B-5 ($2,350,900 rated BB), and Class B-6 ($1,880,886 not rated).

and then to the subordinates in the order of their seniority, meaning that the senior bonds received available principal and interest first; the more junior bonds outstanding would absorb any shortfalls in principal and interest, in reverse priority order. Losses in turn are allocated to the outstanding bond with the lowest priority (i.e., the most junior bond); only if all the subordinate tranches are written down would the senior bonds begin to absorb losses.

Note that while this form of subordination, often referred to as a "six pack" of subordination, was quite common for prime deals (i.e., deals where the mortgage pool contained prime loans) issued in the pre-crisis period (i.e., before 2008), there was more variation to the credit structure of subprime deals as well as deals backed by other forms of collateral. The credit rating agencies also began to allow "micro-tranching" of subordinate bonds in these deals, allowing bonds to be created with "half-ratings" (i.e., AA–, BB+), implying a high level of precision in the credit rating agencies' modeling of expected credit performance.

Subordination can also be utilized within a transaction's senior bonds to create additional layers of credit support for certain tranches. For example, a tranche can be divided into two "child tranches," and one bond (called a "super senior" tranche) is given priority for principal and interest cash flows. The super senior tranche thus has the credit support of both the subordinates and the lower-priority or "mezzanine" bond (which is still a senior tranche, and typically rated AAA). The super senior tranche is targeted at investors with a very low tolerance for credit risk who are willing to accept lower yields for additional protection, while the mezzanine appeals to investors satisfied with the level of subordination and happy to accept the higher expected yield.

Shifting-Interest Provision

The industry has long recognized that the credit quality of a mortgage pool will change over time. This evolution occurs because stronger borrowers take advantage of lower rates and other opportunities to refinance their loans, while weaker-quality borrowers are often locked into their current loans and unable to refinance. This process, typically called adverse selection, means that the credit quality of a typical pool will decline over time as loans to better borrowers leave the collateral pool. As a result, almost all senior-subordinated structures incorporate a provision that causes the credit protection for the senior bonds to increase over time. This provision is known as the shifting-interest provision.

The shifting-interest mechanism provides rules for the payments to the bond classes that reduce the likelihood that over time the level of credit protection is insufficient to adequately support the senior tranches. The level of subordination (also called the subordinate interest) is the percentage of the mortgage balance of the subordinated bond class to that of the mortgage balance for the entire deal. The higher the level of subordination, the greater is the level of protection for the senior bond classes. The shifting-interest mechanism calls for a non-pro rata allocation of prepayments so that the subordinate interest is maintained at an acceptable level (and proportionately increases) in order to protect the senior bond classes as time elapses and the collateral pool evolves. The prospectus will specify how different scheduled principal payments and prepayments will be allocated between the senior bond class and the subordinated bond classes.

The scheduled principal payments are allocated based on the senior percentage (also called the senior interest) which is the ratio of the balance of the senior bond class to the balance of the entire deal and is equal to 100% minus the subordinate interest. Allocation of the prepayments is based on the senior prepayment percentage (in some deals called the accelerated distribution percentage) and is defined as follows:

Senior prepayment percentage = (Shifting-interest percentage × Subordinate interest)

In the above formula, the "Shifting-interest percentage" is set forth in a schedule included in the prospectus supplement. The shifting-interest features are different for prime and subprime deals. While the shifting-interest provisions are fairly homogenous for deals backed by prime loans, the changes in the amount of subordination in subprime transactions were quite deal-specific and varied, based on both the composition of the collateral pool and the other forms of credit enhancement used to support the senior tranches.

The published "Shifting-interest percentage" schedule in the prospectus supplement is only a "base" schedule because the schedule can change over time depending on the performance of the collateral. Should the actual performance be such that the credit protection for the senior bond classes would deteriorate as a result of the scheduled payment to the subordinate bond classes as determined by the trustees, the base shifting-interest percentages are overridden such that a higher allocation of prepayments is made to the senior bond classes. There are tests that are specified that the trustee must compute to determine if the base schedule can be overridden.

The shifting-interest provision is beneficial to the senior bond class holders from a credit standpoint. However, from a cash flow perspective, this provision does alter the cash flow characteristics of the senior bond classes even in the absence of defaults, making their average lives both shorter and more volatile than that experienced with a *pro rata* distribution of prepayments. The size of the subordination also matters. A larger subordinated class redirects a higher proportion of prepayments to the senior bond classes, thereby impacting their average lives even further.

Deal Step-Down Provisions

A step-down provision allows for the reduction in credit support to the bond classes over time. This is permitted if certain conditions as set forth in the prospectus supplement are met. However, if those conditions are not satisfied due to poor collateral performance, step-down provisions are altered. The provisions that prevent the credit support from stepping down are called "triggers." There are two triggers based on the level of credit performance that must be satisfied before the credit support is allowed to be reduced: a delinquency trigger[2] and a loss trigger.[3]

Should a trigger occur, principal payments from the subordinated bond classes are diverted to the senior bond classes. This could involve stopping all principal payments from being distributed to the subordinated bond classes. Or, the occurrence of a trigger may permit the subordinated bond classes to receive regularly scheduled principal (amortization) on a *pro rata* basis but divert all prepayments to the senior bond classes.

Originator/Seller-Provided Credit Enhancement

The originator/seller of the collateral to the special purpose vehicle (SPV) can provide credit support for the transaction in one or a combination of three ways: (1) excess spread, (2) cash collateral, and (3) overcollateralization.

Excess Spread

The excess spread (or excess interest) is the monthly interest payment from the collateral reduced by the total interest rate that must be paid to all of the bond classes in the structure for the month and the total fees (e.g., mortgage servicing and administrative fees) that must be paid for the month.

The monthly excess spread can be either (1) distributed to the seller of the collateral to the SPV, (2) used to pay any losses realized by the collateral for the month, (3) retained by the SPV and accumulated in a reserve account and used to offset not only current losses experienced by the collateral but also future losses, or (4) otherwise used to create credit support (e.g., through generating overcollateralization, as addressed below). Excess spread was typically seen in deals backed by subprime and lower-quality loans that carried note rates much higher than those of senior MBS tranches, and was developed as a way to utilize these interest cash flows to supplement the credit enhancement offered by the subordinates.

Any excess spread retained and accumulated in a cash reserve account can be used to offset current and future losses and acts as a form of credit enhancement. Should there

[2] The delinquency test prevents any step-down from taking place as long as the current over-60-day delinquency rate exceeds a specified percentage of the then-current pool balance.

[3] The principal loss test prevents a step-down from occurring if cumulative losses exceed a certain limit (which changes over time) of the original balance.

be any excess spread remaining in the reserve account after the last liability of the deal is paid off, that amount is returned to the seller of the collateral. Or, if certain conditions are satisfied, and if the cash reserve reaches a certain level, the prospectus supplement may permit further excess spread to be paid to the seller of the collateral.

The determination of how much of the excess spread can be used to satisfy the amount of credit enhancement required by credit rating agencies that rated the deal depends on several factors. The concern is that if there are prepayments and defaults, the amount of the excess spreads will decline over time. Consequently, excess spread may not be a reliable source of credit enhancement and typically serves to augment deals' credit support.

Cash Collateral

There are two ways that the originator/seller can directly supplement a deal's credit support. The first way is by the originator/seller depositing, at the time of the sale of the collateral to the SPV, cash that can be used if the other forms of credit enhancement are insufficient to meet collateral losses. The second is by the originator/seller providing a subordinated loan to the SPV. Both these forms of credit support are viewed as being relatively expensive and inefficient, as they utilize precious liquidity that is needed for other business purposes.

Overcollateralization

When the amount of the collateral exceeds the total face value of all the bond classes, the excess collateral is referred to as overcollateralization (O/C) and can be used to absorb any collateral losses. O/C can take several forms. When the amount of a deal's collateral exceeds the face value of the bonds at issuance, it is referred to as original O/C. A deal's excess spread can also be directed to pay down the value of a transaction's bonds in a process called turboing. Commonly combined with original O/C, turboing reduces the face value of the bonds until a targeted O/C percentage is reached.

Third-Party Credit Enhancements

A common form of credit enhancement used in conjunction with the other forms mentioned above was some type of third-party credit enhancement such as monoline insurance, a letter of credit, or related-party guarantees. Third-party credit enhancements expose the bond classes to third-party credit risk—the risk that the third-party guarantor may be either downgraded or not able to satisfy its commitment.

Today, few, if any, deals are done with insurance by monoline insurers, bank letters of credit, and related-party guarantees. Monoline insurers have been downgraded so that they are no longer able to guarantee triple-A bond classes. Risk-based capital requirements have made letters of credit for banks unattractive. Finally, third-party-related guarantors are rare because the parent of the originator/seller is typically not triple A-rated.

Pool insurance covers losses resulting from defaults and foreclosures. Policies typically are written for a dollar amount of coverage that continues in force throughout the life of the pool. Since only defaults and foreclosures are covered, additional insurance must be obtained to cover losses resulting from bankruptcy, fraud arising in the origination process, and special hazards. We discuss each of these below.

When a borrower files for personal bankruptcy, there is a risk that a bankruptcy judge could reduce the borrower's mortgage debt. This debt reduction, called a *cramdown*, usually occurs only when the value of the borrower's home has fallen so that the mortgage loan balance exceeds the home's market value. If a cramdown is ordered, the loan's terms can be altered by reducing the unpaid principal balance or the loan's interest rate. A few cramdowns have occurred in recent years in settling Chapter 13 bankruptcy cases.[4] However, the 1993 Supreme Court case of Nobelman versus American Savings ruled that a borrower filing under Chapter 13 cannot effectively reduce his or her mortgage debt.

Another potential risk that the cash flows will be impaired arises from borrower fraud or misrepresentation during the application process. This type of risk is often not covered by the originator/conduit/sellers' representations and warranties. The risk of losses due to fraud is front-loaded. That is, borrowers who misrepresent their income, employment, or net worth will generally run into payment problems early in the loan's life. Therefore, fraud coverage is largest at issuance.

Special hazard losses result from properties damaged by earthquakes, mudslides, tidal waves, volcanoes, or floods. Such losses are excluded from coverage under homeowners' and private mortgage insurance policies. Subordinated tranches absorb special hazard losses up to a predetermined capped amount that declines as the mortgage pool amortizes. This "capped" amount is determined by the credit rating agencies. Special hazard losses in excess of this capped amount are distributed among the senior and subordinated classes *pro rata*. Historically, losses from special hazards are quite rare because special casualty insurance is often required on homes in high-risk areas (i.e., flood insurance in flood zones and earthquake insurance along known fault lines) and damage

[4] A mortgage borrower can file for personal bankruptcy under Chapter 7, Chapter 11, or Chapter 13. Chapter 13 allows for restructuring or forgiving debts while letting borrowers retain their assets. In a Chapter 7 bankruptcy filing, a type of bankruptcy that generally involves liquidation of assets to make payments to creditors, cramdowns have also been disallowed under a Supreme Court ruling. Cramdown filings under Chapter 11 are rarer than those under Chapter 7 or Chapter 13 because of their cost and complexity. Jumbo loan borrowers are more likely to file under Chapter 11 because this section can be used only when the debtor's secured debt exceeds $350,000.

caused indirectly by an act of God, such as water damage or fire caused by an earthquake, is often covered under standard homeowners' policies.[5]

Use of Interest Rate Derivative Instruments

Interest rate derivatives are used in private-label MBS as another form of credit support and risk mitigator. The three types of interest rate derivatives used in recent mortgage securitizations have been interest rate swaps, interest rate caps, and interest rate corridors. These derivatives are over-the-counter or dealer products, not exchange-traded products. As a result, they expose the trust to counterparty risk.

The use of derivatives in a transaction is specified in the prospectus supplement as a "permitted asset." For example, here is the enabling language in the prospectus supplement for the $175,000,000 (approximate) Aames Mortgage Trust 2001–3 Mortgage Pass-Through Certificates, Series 2001–3:

> *Permitted Assets* The Amendment permits an interest-rate swap to be an asset of a trust which issues Certificates acquired by Plans in an initial offering or in the secondary market on or after November 13, 2000 and clarifies the requirements regarding yield supplement agreements. An interest-rate swap (or if purchased by or on behalf of the trust) an interest-rate cap contract (collectively, a "Swap" or "Swap Agreement") is a permitted trust asset if it: (a) is an "eligible Swap;" (b) is with an "eligible counterparty;" (c) is held by a trust whose Certificates are purchased by a "qualified plan investor;" (d) meets certain additional specific conditions which depend on whether the Swap is a "ratings dependent Swap" or a "non-ratings dependent Swap" and (e) permits the trust to make termination payments to the Swap (other than currently scheduled payments) solely from excess spread or amounts otherwise payable to the servicer or seller.

The prospectus supplement then defines "eligible Swap," "eligible counterparty," "qualified plan investor," "ratings dependent Swap," and a "non-ratings dependent Swap."

The reasons why the trust may utilize a derivative transaction will be specified. For example, in the prospectus of the $780,000,000 (approximate) Aegis Asset Backed Securities Trust Mortgage Pass-Through Certificates, Series 2004–2 it states:

[5] Another important factor is land value. In costly areas of the country, the value of land can represent more than 50% of the value of a single-family home. Thus, if a home is totally destroyed, the land value acts as a floor in terms of the loan's loss severity. Finally, where damage to property caused by special hazards is uninsured, the homeowner can often get access to low-cost government funds to help rebuild. Therefore, special hazards have not historically resulted in significant losses. In addition, geographic diversification can help to limit a pool's exposure to special hazard risk.

> If specified in the related prospectus supplement, the trust fund may include one or more swap arrangements or other financial instruments that are intended to meet the following goals:
>
> - to convert the payments on some or all of the mortgage loans, private securities or agency securities from fixed to floating payments, or from floating to fixed, or from floating based on a particular index to floating based on another index;
> - to provide payments in the event that any index rises above or falls below specified levels; or
> - to provide protection against interest rate changes, certain types of losses, including reduced market value, or other payment shortfalls to one or more classes of the related series.

Interest Rate Swaps

In an interest rate swap, the counterparties agree to exchange periodic interest payments. The dollar amount of the interest payments exchanged is based on some predetermined dollar principal, which is called the *notional amount* or *notional principal* or *notional principal amount*. The dollar amount a party pays to the other party is the agreed-upon periodic interest rate times the notional amount. The only dollars that are exchanged between the parties are the interest payments, not the notional amount. Accordingly, the notional principal serves only as a scale factor to translate an interest rate into a cash flow. In the most common type of swap, one party agrees to pay the other party fixed interest payments at designated dates for the life of the contract. This party is referred to as the *fixed-rate payer*. The other party, who agrees to make interest rate payments that float with some reference rate, is referred to as the *floating-rate payer*. In private-label mortgage transactions, the trust is usually the fixed-rate payer and a third party (typically a rated affiliate of the underwriter or other bank) is usually the floating-rate payer.

The reference rates that have been used for the floating rate in an interest rate swap are various money market rates: Treasury bill rate, the London interbank offered rate, commercial paper rate, banker's acceptances rate, certificates of deposit rate, the federal funds rate, and the prime rate. The most common reference rate in swaps used for non-agency mortgage-backed products is the London interbank offered rate (LIBOR). LIBOR is the rate at which prime banks offer to pay on Eurodollar deposits available to other prime banks for a given maturity.

There is not just one rate but a rate for different maturities. For example, there is a 1-month LIBOR, 3-month LIBOR, and 6-month LIBOR. Since the liabilities for MBS transactions are generally based on 1-month LIBOR, the hedging instruments are typically based on the same index.

In general, a swap can be used to alter the cash flow characteristics of the assets (liabilities) to match the characteristics of the liabilities (assets). For example, suppose that a pool of mortgage loans has a fixed rate but the bond classes that are supported by the collateral are floating rate. A swap can be used to convert the fixed-rate cash flows to floating-rate cash flows.

The swap we have described thus far is a plain vanilla or generic swap. The swap market is very flexible and instruments can be tailor-made to fit the requirements of issuers who want to use them for hedging the interest rate risk in transactions. The most common non-generic swap type used in private-label MBS transactions is the amortizing swap.

In a plain vanilla swap, the notional amount remains unchanged during the life of the swap. An amortizing swap is a swap in which the notional amount declines over time based on a predetermined schedule. The reason that this type of swap is used when the collateral is a pool of mortgage loans is that the loan pool pays down over time. Hence, the loan pool will eventually be overhedged if a plain vanilla swap is transacted using the pool's notional amount. In practice, when an amortizing swap is used as a hedging instrument, the issuer will construct the notional amount schedule based on amortization and expected prepayments. While this improves the match between the balance of the loan collateral pool and the swap, it does not totally mitigate the risk of a mismatch. The swap is designed to pay down at specific amortization and prepayment rates. Therefore, if the collateral pool pays down faster than the swap's pricing speed, the remaining balance of the swap will be greater than that of the collateral; if it pays more slowly, the swap's balance will be smaller than that of the loans.

Interest Rate Cap

An interest rate cap can be used to hedge against a rise in interest rates. The buyer of the cap pays the seller an upfront fee for this right at closing. The elements of an interest rate cap are (1) the reference rate, (2) the strike rate, (3) the length of the agreement, (4) the frequency with which payments are exchanged, (5) the notional amount, and (6) the prepayment rate. At a settlement date of a cap, the seller of the cap must pay the buyer if the reference rate exceeds the strike rate. The amount of the payment is the difference between the two rates multiplied by the remaining notional amount. If the reference rate is less than the strike rate, then for that settlement date, no funds are exchanged. The cap contracts are typically written to amortize at a specified rate, which means that the same type of balance mismatch noted in the above discussion of swap contracts may occur.

Interest Rate Corridor

An interest rate corridor is an interest rate cap where the liability of the seller is limited to a specified maximum rate (ceiling). For example, the strike rate may be 3% and the ceiling may be 6%. If the reference rate is 1%, no funds are exchanged. If the reference rate is 5%, the seller owes the buyer (5%–3%) multiplied by the notional amount. If the reference rate exceeds the ceiling, the seller owes the buyer (6%–3%) multiplied by the notional amount. Like simple cap contracts, corridors are typically written to amortize at a designated prepayment speed, and the seller is compensated via a single upfront fee.

Basis Risk and Use of Proceeds

In private-label transactions, interest rate derivatives are used to hedge against interest rate scenarios where the benchmark index for the liabilities rises significantly more quickly than the asset benchmark index. This mismatch in indices is called "basis risk."

In most private-label mortgage transactions, the trust's interest liability to bondholders is limited to the amount of interest generated by the collateral (the "Available Funds Cap"). This basis risk shortfall is a risk to investors and can be mitigated by incorporating interest rate derivatives into private-label mortgage transactions.

Proceeds from interest rate derivatives are used for one or more of three purposes including:

1. to cover losses on the collateral;
2. to build overcollateralization by turboing bonds;
3. to cover basis risk shortfall.

Proceeds are directed to these purposes in the waterfall and can be prioritized in any order. It is important to understand the use of the proceeds when analyzing the impact of the derivative on bond cash flows.

Counterparty Risk

The use of derivative instruments introduces counterparty risk for the trust. The risk of counterparty default can be controlled by only entering into swaps with highly rated counterparties and using commonly developed methods in the derivatives market for doing so (e.g., margin, netting, and overcollateralization).

The following extract is taken from the prospectus supplement of Aegis Asset Backed Securities Trust Mortgage Pass-Through Certificates, Series 2004-2 and describes how the trust is to control counterparty risk:

> In "ratings dependent Swaps" (where the rating of a class of securities is dependent on the terms and conditions of the Swap), the Swap Agreement must provide that if the credit rating of the counterparty is withdrawn or reduced by any Rating Agency below a level specified by the Rating Agency, the servicer must, within the period specified under the Pooling and Servicing Agreement: (a) obtain a replacement Swap Agreement with an eligible counterparty which is acceptable to the Rating Agency and the terms of which are substantially the same as the current Swap Agreement (at which time the earlier Swap Agreement must terminate); or (b) cause the Swap counterparty to establish any collateralization or other arrangement satisfactory to the Rating Agency such that the then current rating by the Rating Agency of the particular class of securities will not be withdrawn or reduced (and the terms of the Swap Agreement must specifically obligate the counterparty to perform these duties for any class of securities with a term of more than one year).
>
> . . .
>
> "Non-ratings dependent Swaps" (those where the rating of the securities does not depend on the terms and conditions of the Swap) are subject to a few conditions. If the credit rating of the counterparty is withdrawn or reduced below the lowest level permitted above, the servicer will, within a specified period after such rating withdrawal or reduction: (a) obtain a replacement Swap Agreement with an eligible

counterparty, the terms of which are substantially the same as the current Swap Agreement (at which time the earlier Swap Agreement must terminate); (b) cause the counterparty to post collateral with the trust in an amount equal to all payments owed by the counterparty if the Swap transaction were terminated; or (c) terminate the Swap Agreement in accordance with its terms.

Recent Changes in Credit Support Structures

We conclude this chapter with a discussion of some changes in credit support structures that have come into play after the financial crisis of 2007–8. The demise of the market for subprime loans and the securities backed by them means that the more complicated credit structures are not being utilized at the current time. As virtually no subprime or lower-credit loans with very high note rates are being securitized, deals do not (and cannot) utilize excess spread as a form of credit support.

At the time of this writing, virtually all deals are being created as 144-A private placements with shifting-interest subordination. Most deals still contain step-down tests that assure investors in the senior classes that credit enhancement will remain adequate even if the collateral performs below expectations.[6] Deals tend to have more subordination for the senior bonds than earlier vintages; even deals backed by loans with very strong credit ("mortgages for millionaires" is a popular term) have subordination levels of 7% or higher. However, it is noteworthy that the credit support contains fewer subordinate tranches than the "six pack" of subordinate bonds seen in earlier deals. Prime issued prior to 2008 typically had six subordinate classes, with three investment-grade classes (rated AA, A, and BBB) and three classes with ratings below investment grade (i.e., BB and B-rated classes, along with a non-rated first-loss piece).

Current deals typically still have three investment-grade classes but only two below-investment-grade tranches for a total of five subordinate classes. These changes reflect the credit rating agencies' demand for larger (or "thicker") subordinate tranches that can absorb greater losses and provide more credit support to bonds above them in the credit structure. It also implicitly recognizes a more realistic level of uncertainty with respect to mortgage credit performance than seen in the 2000–7 vintage of transactions. In addition, the credit rating agencies no longer allow "half-ratings" (e.g., AA+), which led to the micro-tranching that allowed the creation of very small and vulnerable subordinate tranches.

[6] Some deals also contain explicit subordination floors that insure that a minimum amount of credit support remains as the deal ages and the loan collateral pays down.

Key Points

- Private-label mortgage securities products expose investors to credit risk due to the absence of any government guarantees.
- For senior tranches to obtain an investment-grade rating, private-label mortgage securities must be structured with credit enhancement (i.e., additional credit support) to absorb expected losses from the underlying loan pool due to defaults.
- There are different credit enhancement mechanisms available to issuers.
- The credit enhancement mechanism(s) utilized are those that provide the issuer with the best execution (i.e., will maximize proceeds from the sales of the pool of mortgage loans after credit enhancement expenses are taken into account).
- Credit rating agencies determine the amount of credit enhancement needed to obtain the issuer's target credit rating (i.e., sizing the transaction) based on the credit quality of the borrowers in the pool and other factors such as the structure of the transaction.
- The process by which the rating agencies determine the amount of credit enhancement needed to obtain a specific credit rating is referred to as sizing the transaction.
- Three forms of credit enhancement are (1) structural, (2) originator/seller-provided, and (3) third-party-provided.
- Structural credit enhancement refers to the redistribution of credit risks among the bond classes included in the structure so as to provide credit enhancement by one bond class to one or more of the other bond classes in the structure by creating a senior-subordinated structure.
- By creating the senior-subordinated bond classes, credit risk is being redistributed among the bond classes in the structure through a process referred to as credit tranching.
- The senior bond class in the capital structure is the bond with the highest credit rating and the subordinated bond classes in the capital structure are those below (i.e., more junior to) the senior bond class.
- The rules for the distribution of the cash flow (interest and principal) among the bond classes, as well as how losses are to be distributed, are set forth in the supplementary prospectus and commonly referred to as the cash flow waterfall.
- The distribution of losses is based on the position of the bond class in the capital structure with losses allocated starting from the bottom (i.e., the lowest or unrated bond class) and progress to the senior bond class.
- Subordination can also be utilized within a transaction's senior bonds to create additional layers of credit support for certain tranches, creating, for example, two "child tranches," and a "super senior" tranche that is given priority for principal and interest cash flows.
- The credit quality of a mortgage pool will change over time because stronger borrowers take advantage of lower rates and other opportunities to refinance their loans, while weaker-quality borrowers are often locked into their current loans and unable to refinance.
- To protect against deteriorating credit quality of a loan pool over time, almost all senior-subordinated structures incorporate a shifting-interest provision that causes the credit protection for the senior bonds to increase over time.
- A step-down provision allows for the reduction in credit support to the bond classes over time if certain conditions as set forth in the prospectus supplement are met. However, if those conditions are not satisfied due to poor collateral performance, step-down provisions are altered.

- The originator/seller of the collateral to the special purpose vehicle (SPV) can provide credit support for the transaction in one or a combination of three ways: (1) excess spread, (2) cash collateral, and (3) overcollateralization.
- Third-party credit enhancement—monoline insurance, a letter of credit, or related-party guarantees—expose the bond classes to third-party credit risk and today, few, if any, deals are done with third-party guarantees.
- Interest rate derivatives are used in private-label MBS as another form of credit support and risk mitigator.
- The three types of interest rate derivatives used in mortgage securitizations have been interest rate swaps, interest rate caps, and interest rate corridors.
- Following the financial crisis of 2007–8 and the demise of both the market for subprime loans and securities backed by them, the more complicated credit structures are no longer being utilized.
- Today, virtually all deals are being created as 144-A private placements with shifting-interest subordination, and most deals still containing step-down tests; deals tend to have more subordination for the senior bonds and fewer subordinate classes than earlier vintages.

CHAPTER 21

INTRODUCTION TO COVERED BONDS

THOMAS SCHOPFLOCHER AND JORDAN MILEV

AFTER reading this chapter you will understand:

- the basic properties of mortgage covered bonds;
- how mortgage covered bonds compare to MBS and corporate debt;
- which countries issue and provide markets for mortgage covered bonds;
- historical performance and liquidity of mortgage covered bonds;
- the market for mortgage covered bonds in the US;
- the potential for a developed mortgage covered bond market in the US.

Throughout Europe and various other parts of the world, some mortgages are funded via a debt vehicle called a *mortgage covered bond*. Mortgage covered bonds have been around for over 240 years and offer a host of attractive properties to both issuers and investors. To date, there has never been a single covered bond default. Yet despite this attractive track record, mortgage covered bonds have not caught on in the US.

While there have been mortgage covered bonds denominated in US dollars, they are the minority, and they have overwhelmingly been issued by non-US entities. Their lack of popularity in the US creates a hurdle as to the effective use of mortgage covered bonds as a mortgage funding vehicle in the US housing markets. This hurdle is attributable, in part, to the long-standing presence of the US government-backed programs in place: Ginnie Mae, Fannie Mae, Freddie Mac, and the FHLB system. While these programs are the predominant means of funding mortgages in the US, their existence and the advantages they confer were called into question after the credit crisis of 2007–9. In particular, the originate-to-distribute model that these programs engender has been a central point of criticism because it transfers risk away from the originator and onto investors.

After the credit crisis, which was sparked by problems in the subprime housing and securitization markets, there has been discussion as to whether mortgage covered bonds might provide a viable alternative means of funding mortgages in the US. Indeed, there have been two US covered bond programs in the US (Washington Mutual in 2006 and Bank of America in 2007); however, as of yet, there is no statute, as is the case in European countries, that would govern a covered bond market in the US. Instead, covered bond programs operated by US-based entities are governed by contractual provisions specific to these individual issuers.

In this chapter we examine mortgage covered bonds, beginning with an explanation of their structure, history, and basic properties. We then discuss performance characteristics from the viewpoints of both the issuer and the investor. Because mortgage covered bonds are primarily a European debt security, we examine mortgage funding via covered bonds and the various European covered bond markets. Finally, we discuss the possibility of the development of a covered bond market in the US, concentrating on the two US covered bond programs to date.

Overview and Introduction to Mortgage Covered Bonds

In this section we discuss the structure of covered bonds, examining the role and treatment of the underlying mortgage pool, as well as accounting and regulation. Because of the similarities between MBS and covered bonds, we compare the two security classes when appropriate. We also review the history of covered bonds, starting from inception in the eighteenth century right through the credit crisis until the present day. Finally, we discuss basic properties of covered bonds, with an emphasis on bond features (such as maturity, repayment of principal, coupon, etc.), ratings (including what the agencies consider), and issuance considerations.

Covered Bond Structure

A covered bond is an on-balance-sheet, corporate debt instrument issued by a regulated credit institution. Through a mechanism called *dual recourse*, covered bond holders have recourse—in the event of issuer failure—not only to the issuing credit institution, but also to a pool of assets (mortgages, in the case of a mortgage covered bond), called a *cover pool*, that is owned and maintained by the issuer.[1] Finally, the obligations of the credit institution are supervised by an independent regulatory body.[2]

Because they are backed by the cash flows from a defined pool of loans, covered bonds bear some similarities to asset-backed securities (ABS) or mortgage-backed securities

[1] Sabine Winkler and Alexander Batchvarov, "Covered Bond Primer for the Uninitiated," Bank of America/Merrill Lynch (January 22, 2010), 6.

[2] John Lonsdale, "Understanding the Key Elements of Covered Bonds Legislation." Speech at Insto Covered Bonds Congress (August 2011).

(MBS), which are created through the securitization process—familiar to and well understood by US markets. In several important respects, however, the structure of covered bonds gives rise to features that differ from those of securitized products. These structural features and their advantages and disadvantages merit special attention and are discussed below.

Historically, covered bonds arose in the context of funding mortgages, and to this day, mortgages serve as the primary source of underlying assets in the covered bond market. While generalizations can be made, we will focus on mortgage covered bonds[3] and compare and contrast to MBS as appropriate. For simplicity, we will refer to mortgage covered bonds simply as *covered bonds*.

Dual Recourse

In most cases, traditional covered bonds are direct obligations of the issuing bank, which meets coupon payments through its operating income. In this sense, covered bonds resemble a bank's senior, unsecured debt. In the event of default, however, creditors have dual recourse to both the issuer and the underlying cover pool. To the extent that claims are not met by the issuer, covered bond holders are on comparable footing to the senior, unsecured debt holders in terms of their priority for recovering capital.[4] These features make covered bonds a type of secured debt. There are, however, certain differences between ordinary secured debt and covered bonds:

- Ordinary secured debt gives investors recourse to the issuer in case of collateral deficiency. Covered bonds have exclusive rights to cover pool assets; and if this is insufficient, through dual-recourse, covered bond holders then have an unsecured claim against the issuer.[5]
- Ordinary secured debt does not segregate collateral; whereas, in the case of covered bonds, investors have exclusive claims on the cover pool.[6]
- Ordinary secured debt has a static collateral pool, unlike covered bonds, which have a dynamic collateral pool.

A notable exception to the dual recourse feature arises in the case of covered bonds issued in the US. Consistent with strong traditions in the US securitization markets, bond holders of US covered bond issues do not have recourse to the issuing bank itself because the notes are obligations of a bankruptcy-remote, special purpose entity (SPE).

[3] Many other types of loans besides mortgages can back covered bonds, e.g., public-sector loans and ship loans.

[4] Winkler and Batchvarov, "Covered Bond Primer for the Uninitiated," 6.

[5] Rebeca Anguren Martín, José Manuel Marqués Sevillano, and Luna Romo González, "Covered Bonds: The Renaissance of an Old Acquaintance," *Banco de España Estabilidad Financiera, Núm. 24*, 71.

[6] Anguren Martín, Marqués Sevillano, and Romo González, "Covered Bonds: The Renaissance of an Old Acquaintance," 71.

Ring-fenced Collateral

In typical covered bond issuances, covered bond collateral is owned by the issuing bank. Unlike MBS, whose underlying asset pool pays down through amortization and prepayments, the asset pool of a covered bond must be dynamically maintained such that the quality and size of the overall pool do not deteriorate as long as notes are outstanding.[7] In this sense, covered bonds resemble a highly rated, credit card ABS structure. In addition to the maintenance of an asset pool, credit card ABS are priced comparably and typically feature a similar bullet payment structure.[8]

Substitution

The value of the asset pool underlying a covered bond must at all times be sufficient to cover note holder claims. For this reason, maturing and nonperforming collateral is replaced with new, performing collateral as needed.[9]

Overcollateralization

Covered bond issues typically involve a cover pool that exceeds the notional value of notes outstanding by a specified percentage. This *overcollateralization* assures the timely payment of principal and interest to the note holders, even if the issuer itself fails.[10]

The overcollateralization of a covered bond is dynamic and can vary due to (1) the amount of covered bonds issued by the bank or (2) how many of the bank's covered bonds have matured. The bank has a legal obligation to maintain the assets in the cover pool such that contractual overcollateralization tests are satisfied. Ratings agencies consider overcollateralization when applying their ratings.

On-Balance-Sheet Accounting

Unlike MBS, which involve a true sale of the underlying assets into a bankruptcy-remote trust, the underlying assets backing covered bonds are owned by the issuing bank and are therefore treated as on-balance-sheet items for accounting purposes.

Supervision by an Independent Regulatory Body

Covered bond issuers' obligations are supervised by a public or other independent body. This supervision is specifically in respect of the cover pool. Features of this supervision involve (1) a *cover pool monitor*; (2) regular audits of the cover pool by the monitor; and (3) continued management and maintenance of the cover pool in the event of the issuer's insolvency, thus assuring timely payment of principal and interest to note holders.[11]

[7] Winkler and Batchvarov, "Covered Bond Primer for the Uninitiated," 6.

[8] Katie Reeves, "US Covered Bonds Uncovered," *Global Securitisation and Structured Finance*, Deutscher Bank (2007), 66–7.

[9] Winkler and Batchvarov, "Covered Bond Primer for the Uninitiated," 6.

[10] Anguren Martín, Marqués Sevillano, and Romo González, "Covered Bonds: The Renaissance of an Old Acquaintance," 70.

[11] European Covered Bond Council, "Essential Information," Part Four. Available at <http://ecbc.hypo.org/Content/default.asp?PageID=503>.

The role of the cover pool monitor is somewhat akin to that of a trustee in an MBS or ABS structure in that it represents the interests of the security holders through the maintenance of the collateral pool.

Legislative vs Structured

There exist two main types of covered bonds: *legislative* and *structured*. Legislative covered bonds arise in some countries, when issuance is governed by a specific legislative framework. As such, legislative covered bonds are established by statutory law, and characteristics can vary among different countries. Structured covered bonds are issued through private contractual agreements. Structured covered bonds arose out of demand in markets that lacked covered bond legislation. Examples of such markets include those of the UK, Canada, and notably, the US.[12]

Acceleration

In the event that an issuer fails, covered bonds adhere to the payment schedule to the extent that the collateral permits. Only if the cover pool is insufficient to support full principal and interest payment would the covered bonds be accelerated.[13] While this feature is similar to MBS inasmuch as MBS payment structures depend on underlying collateral cash flows, it is unlike the case of many other forms of debt, for which acceleration depends on contractual terms.

Covered Bonds Compared to MBS

In Figure 21.1, we present a stylized schematic of how mortgage securitization works. In contrast to the traditional mortgage funding model, in which banks fund mortgages directly through deposits, securitization involves multiple parties, including a bankruptcy-remote SPE that issues notes to investors. In this way, MBS obtain ratings that are

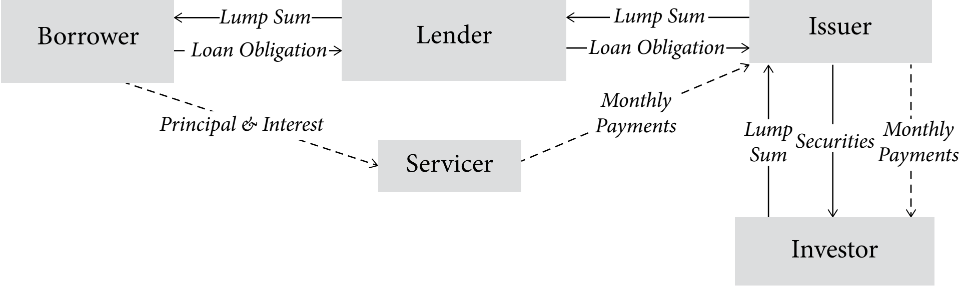

FIGURE 21.1 MBS structure

[12] Anguren Martín, Marqués Sevillano, and Romo González, "Covered Bonds: The Renaissance of an Old Acquaintance," 70.
[13] American Securitization Forum, "U.S. Covered Bonds: A Discussion Paper for the Federal Deposit Insurance Corporation," 4.

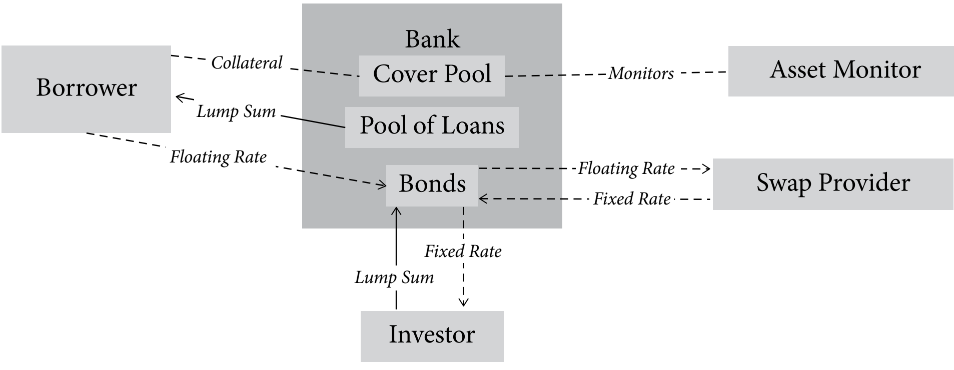

FIGURE 21.2 Covered bond structure

dictated by credit enhancement and are entirely decoupled from the credit rating of the lending/originating/securitizing entity.

In the case of securitizations, like MBS, one observes that investors make lump sum payments in return for securities issued by a bankruptcy-remote trust, which we shall refer to as the SPE. The actual lender neither issues the MBS nor does it necessarily service the cash flows from the mortgage borrowers to the investors.

In Figure 21.2, we illustrate the basic framework for how European covered bonds (which comprise the vast majority of issuance) are structured. As discussed earlier, assets in the cover pool remain the property of the issuing bank. On the other hand, like MBS, investors effectively fund the mortgage assets in the pool through their purchase of the bonds.

The mechanics of a covered bond involve investors who pay a lump sum to the issuer in return for a (typically) fixed rate of return. Because the borrowers usually pay a floating rate, a swap provider is often engaged to hedge the interest rate risk that would otherwise be incurred by the bank. An important feature of covered bonds is the independent asset monitor that is responsible for ensuring the continued performance and quality of the cover pool, which remains on the bank's balance sheet.

Comparison of Covered Bonds to MBS and Structured Debt

While covered bonds do not adhere to a standard definition that applies across all issuances, there are certain commonalities that make covered bonds a sort of hybrid between ordinary secured debt and MBS. One of these features is dual recourse, which sets covered bonds apart from both MBS and secured debt.[14] Table 21.1 compares various features for covered bonds, MBS, and secured debt.[15]

[14] Winkler and Batchvarov, "Covered Bond Primer for the Uninitiated," 7.

[15] Adapted using information from Winkler and Batchvarov, "Covered Bond Primer for the Uninitiated," and Anguren Martín, Marqués Sevillano, and Romo González, "Covered Bonds: The Renaissance of an Old Acquaintance."

Table 21.1 Properties of covered bonds, MBS, and secured debt

	Covered Bonds	MBS	Secured Debt
Issuer	Regulated financial institution	SPE	Regulated financial institution
Balance sheet treatment	On-balance sheet funding, with a segregated pool of assets	Off-balance sheet treatment	On-balance sheet, with no segregation of assets
Payment Source	P/I come from issuing financial institution; assets serve as collateral; principal typically repaid in a bullet structure	P/I paid from the proceeds of the assets; timing of P/I depends on the structure	P/I come from the issuing financial institution; usually a bullet structure
Ratings	Depends on the rating of the issuer	Depends on the tranche of the MBS; unrelated to the rating of the issuing financial institution	Senior unsecured debt rating of the issuer
Investor recourse	Dual recourse	No recourse to the bank if the asset pool suffers shortfalls	Recourse to the issuer if collateral is insufficient
Asset pool management	Dynamic collateral management, including substitution	Static pool	Static pool
Overcollateralization	Yes, must be maintained	Yes, but need not be maintained	Depends on the tranche
Supervision	Cover pool monitor, ratings agencies	Trustee, ratings agencies	Issuer, ratings agencies
Acceleration	Not unless cover pool falls short, can depend on the contract	Depends on servicer and breach of performance triggers	Depends on the contract

History of Covered Bonds

With its origins dating back to the eighteenth century, the German *Pfandbriefe* market is the oldest covered bond market in the world. Broadly speaking, Pfandbriefe are recourse obligations of an issuing bank, which are secured by a pool of assets.[16] Pfandbriefe started in Prussia as a mechanism to fund mortgages and address the financing issues that arose in the aftermath of the Seven Years' War.[17]

The Prussian King introduced "Landschaften,"—essentially cooperative mortgage credit institutions[18]—which issued debentures called Pfandbriefe. In this way, members

[16] ECBC, *2014 ECBC European Covered Bond Fact Book* (September 2014), 3.
[17] ECBC, *2014 ECBC European Covered Bond Fact Book*, 3–4.
[18] See <http://ineteconomics.org/grants-research-programs/grants/growth-and-credit-mortgage-securitization-through-landschaften-in-prussia>.

could secure debt and raise capital from lenders/investors. These debentures were secured by mortgages on member property. Landschaften would issue debentures to members, who in turn used them to raise capital by transferring the debenture to a creditor. In this way, the creditors assumed a lien on secured property.[19] Shortly after the advent of Pfandbriefe in Prussia, similar debt instruments arose in Denmark and later other parts of Europe.[20]

Covered bonds play a dominant role in Europe and other parts of the world, such as Canada,[21] for providing mortgage funding. In the US, however, the primary source of funding remains securitization (agency and non-agency), repo funding, and Federal Home Loan Bank System (FHLBS) advances. There have been only two covered bond issues from US financial institutions to date. Washington Mutual (WaMu) issued the first US covered bonds (backed by US residential mortgage loans) in September 2006. Bank of America (BoA) issued similarly structured covered bonds in 2007.

The credit crisis was precipitated by structural problems in US housing finance and lending, which led to the collapse of subprime markets and had a lasting effect on the private-label securitization industry. One of the hallmarks of the subprime crisis was the overwhelming degree to which many AAA (as well as lower-rated) subprime and Alt-A MBS were downgraded by the ratings agencies and eventually experienced elevated default rates. In many instances, investment grade bonds, backed by subprime and other nonconforming collateral, suffered extensive losses.

In contrast to the US experience, there have been no covered bond defaults in their entire history of over 240 years.[22] The credit crisis, which was not localized to US markets, provided an informative stress test for the resilience of covered bonds. While their credit ratings decreased, the outstanding bonds remained intact and the maturing bonds have paid off in full. The juxtaposition of the US experience throughout 2007–9 with the European one has led some to suggest that covered bonds could complement or even supplant the agency-driven system in the US. To date, however, covered bonds have not gained significant traction in US markets.

Basic Properties of Covered Bonds

Covered bonds can vary in terms of their maturity, principal payout structure, coupon type, and other basic features. Some of these properties give rise to risks that are considered when ratings agencies assess covered bonds. In order to achieve successful issuance, covered bonds are structured to have properties that conform to investor demand.

19 ECBC, *2014 ECBC European Covered Bond Fact Book*, 3–4.

20 Vinod Kothari, "Introduction to Covered Bonds," 5. Available at <http://vinodkothari.com/wp-content/uploads/2013/11/Introduction-to-Covered-Bonds-by-Vinod-Kothari.pdf>.

21 ECBC, *2014 ECBC European Covered Bond Fact Book*, 40.

22 "Overview of Covered Bonds in Europe," *HSH Nordbank*, 3.

Bond Features

Typical maturities for covered bonds are in the neighborhood of three to ten years; however, they can often be extended to up to 15 years.[23] This relatively short maturity is similar to certain consumer ABS bonds, but is unlike the standard MBS issuance, which typically has a 30-year maturity. Some covered bonds provide for a maturity extension of up to one year if the issuer is insolvent. Sometimes called a *soft bullet* structure, this extension provides time to obtain proceeds from the cover pool and meet principal payment obligations on outstanding notes.[24]

Covered bonds are typically structured such that all principal is paid back at the final maturity date in a single payment. This is often referred to as a *bullet* structure and stands out in contrast to many MBS securitizations (passthroughs in particular), which involve the gradual (and often unpredictable) repayment of principal over the period that the note is outstanding.

Not all covered bonds are structured as bullets, however. In some instances, there may be an embedded call feature, which is retained by the issuer. Maturities on such bonds are often longer than fixed-rate bullets. Because of the negative convexity of its price/interest rate profile, a callable covered bond bears a closer resemblance to an MBS than does a fixed-rate bullet.

Covered bonds are coupon bearing and typically pay a periodic, fixed interest rate to the note holder. While this is generally the case, some covered bond markets, such as the Danish market, have floating-rate covered bonds that may also include rate caps.[25]

The payment of interest coupons and the repayment of principal are, in the case of covered bonds, not linked directly to the cash flow of the cover pool. This feature transfers some of the risks associated with cash flow timing uncertainty—namely prepayment and extension risk, which are associated with most MBS—away from the investor and onto the bank. To the extent that they are present, however, floating-rate or call features create cash flow timing uncertainty that is factored into the spread at which covered bonds are issued.

There do remain several other sources of spread that make covered bonds suitable for some investors. Features that contribute to the return of covered bonds include the strength of the legal/regulatory framework, collateral quality, credit quality of the issuer, product maturity, price performance, and transparency.[26]

Ratings

One of the defining features of MBS is their bankruptcy-remote status. Because they are issued by an SPE (the Trust), ratings of MBS are decoupled from those of the entity that

[23] Jerry Marlatt, Jeremy Jennings-Mares, and Peter Green, "An Analysis of Covered Bonds and the US Market," *Practical Law*. Available at <http://media.mofo.com/files/Uploads/Images/140301-Analysis-of-covered-bonds-and-US-market.pdf>.

[24] Marlatt, Jennings-Mares, and Green, "An Analysis of Covered Bonds and the US Market."

[25] "Danish Covered Bonds," *Nykredit*. Available at <http://www.nykredit.com/investorcom/ressourcer/dokumenter/pdf/Danish_covered_bond_web.pdf>.

[26] Winkler and Batchvarov, "Covered Bond Primer for the Uninitiated," 1.

structured the deal. In this way, MBS investors are insulated from the financial condition of the structuring bank and ratings move independently from those of the bank.

While covered bonds are generally issued directly by a financial institution, the financial condition of the issuer is just one of several features that the ratings agencies monitor when assigning ratings to covered bonds. This means that, to some extent, the ratings of the issuer and the covered bond can move independently.

Covered bonds typically receive the highest ratings by the rating agencies. This feature puts them on equal footing in terms of credit risk with government or Treasury bonds.[27] Compared to senior, unsecured debt, covered bonds provide cheaper, long-term funding because the dual recourse decouples (to some degree) the credit quality of the bond with that of the issuer. As such, the ratings of covered bonds tend to lie in the range of AAA to AA1,[28] and almost 90% of European covered bonds are rated AAA (on Moody's scale).[29]

While covered bonds are generally highly rated and have never experienced defaults, they do carry certain risks that the ratings agencies attempt to capture. The main drivers behind Moody's covered bonds rating are:[30]

- **Strength of the sponsor bank**: The risk to covered bond holders depends on the probability that an issuing bank defaults. Because the issuing bank may handle certain operational aspects of covered bonds, such as servicing, disruptions in banks' continued functioning can threaten both the timely payment of principal and interest to note holders, and the maintenance of the cover pool.
- **Cover pool credit quality**: The collateral score (indicating credit support needed to assure an AAA rating) assigned to a cover pool is determined in an analogous way to how required credit enhancement is determined in the case of a structured MBS deal.
- **Refinancing risk**: Covered bonds are usually issued with short- to medium-term maturities, usually on the order of three to ten years. These maturities tend to be shorter than those of the underlying mortgage assets in the cover pool. This means that in the event of an issuer default, it is likely that the principal amortization of the mortgages will be sufficient to meet the bullet repayments of principal to note holders. Moody's therefore estimates the discount to par that would likely be realized if the cover pool had to be sold in order to recover the necessary principal.
- **Interest rate and currency risk**: To the extent that there are interest rate or currency mismatches between the cover pool mortgages and the covered bonds, these need to be accounted for when modeling the ability of the cover pool to meet note holder claims in the event of an issuer default.

[27] Raquel Bujalance and Eva Ferreira, "An Analysis of the European Covered Bond Market." Available at <http://www.uibcongres.org/imgdb/archivo_dpo3674.pdf>.

[28] Anguren Martín, Marqués Sevillano, and Romo González, "Covered Bonds: The Renaissance of an Old Acquaintance," 70–1.

[29] Moody's Investors Service, "Structured Finance in Focus: A Short Guide to Covered Bonds."

[30] "Structured Finance in Focus: A Short Guide to Covered Bonds."

Issuance

Covered bonds can be issued either as a single issuance or as part of a program.[31] The advantage of a program is that multiple deals can be issued with only one set of governing documents. This translates into cost savings over many deals because an infrastructure is in place in the case of a covered bond program.[32]

In the US, covered bonds are regulated as securities and must be registered under the Securities Act or be exempt from registration (through, for example, Rule 144A).[33] 144A offerings have the advantage that the issuer does not need to engage with US regulators and can therefore bring deals to market quickly. On the other hand, 144A offerings cause the securities to be "restricted." This in turn makes the bonds unavailable to many investors. Such limitations are expected to affect secondary market pricing and liquidity.[34]

Performance Characteristics of Covered Bonds

Risk tolerance, duration and yield requirements, accounting needs, and other investor characteristics can vary widely among investors. From the investor's perspective, covered bonds offer certain advantages and suffer from some disadvantages relative to other fixed-income products. Covered bonds also present certain advantages and disadvantages to an issuer that is seeking funding via residential mortgage markets.

Covered Bond Advantages: Issuer Perspective

From the issuer's perspective, covered bonds offer a wide investor base, elevated credit ratings, low funding costs, and cash flow characteristics that facilitate asset–liability management.

Wide Investor Base

Covered bonds provide funding diversification because they attract a wide investor base, which includes new credit investors, insurance companies and asset managers,

[31] Anna T. Pinedo, Jerry R. Marlatt, and Melissa D. Beck, "Frequently Asked Questions about Covered Bonds," Morrison & Foerster LLP (2015). Available at <http://media.mofo.com/files/Uploads/Images/FAQsCoveredBonds.pdf>.

[32] Felipe Ossa, "IFC Takes a Look at Future Flows," *Asset Securitization Report* (May 22, 2009). Available at <http://www.structuredfinancenews.com/issues/2008_61/-193603-1.html>.

[33] Pinedo, Marlatt, and Beck, "Frequently Asked Questions about Covered Bonds."

[34] See US Covered Bonds, "Basics of the U.S. Market," <http://www.us-covered-bonds.com/news-views/basics-of-the-u-s-market/>, last updated December 28, 2015.

and investors in sovereign and agency debt.[35] Also, because of their relatively simple structure and transparency, covered bonds are easily explained to stockholders and investors.

Part of the reason for the wide investor base is that, under Basel III, covered bonds qualify as Level 2 investments for the purposes of calculating the liquidity coverage ratio. Level 2 assets can account for 40% of liquid asset stock. This makes covered bonds attractive for institutional investors.[36]

Elevated Credit Ratings

As discussed already, covered bonds have ratings that are generally decoupled from those of the issuing entity. Also, because covered bonds provide an incentive for prudent loan origination, regulators generally view covered bonds favorably. The dual-recourse feature, high regulatory standards, and a continuously monitored cover pool mean that covered bonds often have ratings that exceed those of the issuer.[37]

Lower Funding Costs

Because covered bonds can be issued at ratings that often exceed those of their issuing banks, required coupons are lower than if the bank were to have issued senior, unsecured debt. Furthermore, European covered bond markets allow the issuer to enjoy higher pricing power than it would have in the less liquid, unsecured debt markets.[38]

Asset–Liability Management

Covered bonds often have maturities that exceed seven years. This relatively long maturity (as compared to medium-term notes) allows issuers to match financing with the expected life of the assets.[39] Asset–liability management with covered bonds is improved as compared to many US MBS structures, which are generally short a prepayment option and exhibit uncertain cash flow timing.

The short prepayment option—retained by the bank in the case of a covered bond—is less of an issue with European covered bonds. Other than in Denmark, European mortgages typically carry prepayment penalties, which tend to extend the average life of collateral mortgage pools.[40] Also, European mortgages generally have adjustable-interest note rates and are therefore less sensitive to interest rate moves in terms of prepayment behavior.

35 "Uncovering Covered Bonds," PricewaterhouseCoopers (June 2012), 6–7. Available at <http://www.pwc.com/en_GX/gx/banking-capital-markets/assets/pwc-uncovering-covered-bonds.pdf>.

36 "Uncovering Covered Bonds," 7.

37 "Structured Finance in Focus: A Short Guide to Covered Bonds."

38 "Structured Finance in Focus: A Short Guide to Covered Bonds."

39 "Structured Finance in Focus: A Short Guide to Covered Bonds."

40 Michael Lea, "International Comparison of Mortgage Product Offerings," Research Institute for Housing America (September 2010), 21. Available at <http://www.housingamerica.org/RIHA/RIHA/Publications/74023_10122_Research_RIHA_Lea_Report.pdf>.

Covered Bond Advantages: Investor Perspective

From the perspective of the investor, covered bonds provide diversification, strong credit quality, good liquidity, and a yield that is reasonably high given the instrument's historically low-risk profile.

Diversification

Covered bonds offer investors exposure to mortgage markets without substantial credit exposure. Due to their transparency and simplicity, covered bonds may offer an attractive alternative to MBS, especially the more complex structured products.

Credit Quality

Covered bonds have a long history with no defaults to date, and are usually highly rated.[41] Because the issuer retains a 100% interest in the asset pool, the interest of issuer and investor are aligned. In contrast, MBS have been associated with an originate-to-distribute model, which involves the bank originating loans only as a means of collecting a fee once it sells the pool of loans. This process can create a moral hazard problem for the investor because there is no clear incentive or mechanism for the bank to monitor and control the quality of the loan pool.[42]

Liquidity

Because of the size of the European covered bond markets, covered bonds tend to be liquid.[43] Especially in the larger covered bond markets, such as the German and Spanish ones, covered bonds trade with tighter bid–ask spreads than European ABS and MBS. This does not always hold, however, as there have been periods when the opposite is true.[44]

In one study, which considered the period from 2009–13, covered bonds were found to exhibit bid–ask spreads that ranged from 0.20% to 0.40% of the amount traded. Whereas, for the same period, the bid–ask spreads for European MBS were found to be 0.98% of amount traded.[45] In absolute terms, European covered bonds' bid–ask spreads typically range between 10–60 basis points, in normal markets. As a point of comparison, consider the highly liquid, US agency, passthrough MBS market. The most liquid

[41] "Structured Finance in Focus: A Short Guide to Covered Bonds."

[42] Santiago Carbó-Valverde, Richard J. Rosen, and Francisco Rodríguez-Fernández, "Are Covered Bonds a Substitute for Mortgage-Backed Securities?" *Federal Reserve Bank of Chicago WP 2011–14* (November 2011), 2.

[43] Renzo G. Avesani, Antonio Garcia Pascual, and Elina Ribakova, "The Use of Mortgage Covered Bonds," *IMF Working Paper* (January 2007), 7. See also "Covered Bonds in the EU Financial System," *European Central Bank Eurosystem* (December 2008). Available at <https://www.ecb.europa.eu/pub/pdf/other/coverbondsintheeufinancialsystem200812en_en.pdf>.

[44] William Perraudin, "Covered Bond versus ABS Liquidity: A Comment on the EBA's Proposed HQLA Definition" (January 24, 2014), 2. Available at <http://www.afme.eu/WorkArea/DownloadAsset.aspx?id=10360>.

[45] Perraudin, "Covered Bond versus ABS Liquidity," 16.

segment of that market is that of TBAs, which have a 5 basis point bid–ask spread. Bid–ask spreads for specified pools, on the other hand, have closer to 50 basis points.[46]

Yield

Covered bonds, which typically offer dual recourse to the investor, involve a cover pool that remains on the balance sheet of the issuing bank. In this sense, covered bonds are not a securitization, but rather resemble a secured bond. While MBS are generally passthrough entities that expose the investor to the risks of cash flow timing variability, covered bonds avoid these features altogether. Because cash flows are decoupled from the cover pool, covered bonds can often be structured with bullet maturities. That is, principal is repaid in its entirety at maturity, curbing the prepayment and extension risk associated with MBS.

This reduction in risk comes at a cost, however. Broadly speaking, AAA-rated MBS trade at wider spreads than covered bonds.[47] The relatively low yields of covered bonds are historically comparable to those of sovereign debt, largely because of the dual-recourse feature.[48]

Covered Bond Disadvantages: Issuer Perspective

Covered bonds may not be suitable for some issuers due to coverage ratio requirements, cash flow timing uncertainty, and lower funding opportunities through US agency programs.

Coverage Ratios

Relative to securitization and FHLBS advances, the use of covered bonds to finance mortgage holdings involves higher capital requirements versus MBS when held as investments. As discussed, issuing banks retain credit risk in the case of covered bonds. In the US, therefore, banks must hold 4% of capital against mortgages that serve as collateral for covered bonds. In the case of agency MBS, banks need only hold 1.6%.[49]

Transfer of Cash Flow Timing Risk

While lack of cash flow timing risk is a hallmark of covered bonds from the investor's perspective, this risk is transferred to a bank that may be averse to retaining prepayment risk/extension on the mortgages backing covered bonds.[50]

46 James Vickery and Joshua Wright, "TBA Trading and Liquidity in the Agency MBS Market," *FRBNY Economic Policy Review* (May 2013), 7. Available at <http://www.newyorkfed.org/research/epr/2013/1212vick.pdf>.

47 Neil Mehta, "Covered Bonds Shunned amid Low Yields," *Markit* (April 14, 2015).

48 "Uncovering Covered Bonds," 15.

49 Congressional Budget Office, "Alternative Approaches for the Future of the Secondary Mortgage Market," in *Fannie Mae, Freddie Mac, and the Federal Role in the Secondary Mortgage Market* (December 2010), 48–9. Available at <https://www.cbo.gov/sites/default/files/12-23-fanniefreddie.pdf>.

50 Congressional Budget Office, "Alternative Approaches for the Future of the Secondary Mortgage Market," 48–9.

Federal Guarantee

In the US, banks can either use repo funding or borrow cheaply against their mortgage holdings through FHLBS advances. Because of their implicit federal guarantee, members of the FHLBS enjoy lower funding costs than do private financial institutions. The viability of a US covered bond market is called into question while the FHLBS retains this funding advantage.[51]

Covered Bond Disadvantages: Investor Perspective

Covered bonds may be unsuitable for some US investors due to limited liquidity relative to agency MBS, and also because of regulatory issues that render unclear the claims that investors have to the collateral pool in the event of default.

Liquidity in the US

Covered bonds are highly liquid instruments in Europe. When compared to the agency TBA market, however, covered bonds cannot compete in terms of liquidity. This problem is exacerbated by the FDIC's limits on the sizes of bond issues as a percentage of banks' total liabilities.[52]

Regulatory Issues in the US

Unlike in Europe, the US does not have a legal framework that sets forth the priority of claims to collateral if a covered bond issuer becomes insolvent. Without such a statute in the US, it is unlikely that covered bond markets will develop the substantial investor base seen in Europe and other parts of the world.

Covered Bonds and Mortgage Funding in Europe

The landscape of mortgage funding in Europe is somewhat different from that in the US. According to the European Mortgage Federation, retail deposits remain the predominant source of mortgage funding in the European Union.[53] However, mortgage funding

[51] Congressional Budget Office, "Alternative Approaches for the Future of the Secondary Mortgage Market," 48–9.
[52] Congressional Budget Office, "Alternative Approaches for the Future of the Secondary Mortgage Market," 48–9.
[53] See European Mortgage Federation, "Mortgage Funding: Summary," <http://www.hypo.org/Content/Default.asp?PageID=448>.

by covered bonds has increased in recent years and now accounts for 20% of total funding. Because there are no centralized funding agencies as with the US, securitization takes place only to a limited extent in private-label markets.[54]

There are major covered bond programs from Germany (Pfandbriefe), France (several varieties, including Caisse de Refinancement de l'Habitat, Obligations Foncières, Obligations à l'Habitat, and covered bonds based on general law), Spain (Cédulas Hipotecarias), United Kingdom (regulated and unregulated covered bond programs), Belgium, Luxembourg (Lettres de Gage hypothécaires, Lettres de Gage mobilières, Lettres de Gage mutuelles, Lettres de Gage publiques). By far the greatest volume of issuance in the last year has been from Denmark (Realkreditobligationer, Særligt Dækkede Obligationer, and Særligt Dækkede Realkreditobligationer programs).

With long historical precedent and established legal framework, many of the European programs share similar general features. Issuers are either specialized credit institutions or credit institutions with a specialized license to issue covered bonds.[55] Notably, bondholders have direct recourse to the credit institution in the event of default, as covered bonds are obligations of the issuing entity and payable from assets which remain on the books of the issuing credit institution.

Bankruptcy is handled through specific legal frameworks that apply, rather than the standard bankruptcy procedure. Cover pools may include obligations by public-sector entities, credit institution obligations, mortgage loans, and in certain types of programs other loans, such as ship loans, aircraft loans, and others.

Issuance and Outstanding

As of 2014, over €2 trillion in covered bonds were outstanding worldwide. The majority of this outstanding debt originates from six countries in Europe: Denmark, Spain, Sweden, Germany, France, and the United Kingdom. The total amount of covered bond debt outstanding as of 2014 for these countries is listed in Table 21.2. There, one observes Denmark ranks the highest, followed by Spain and then Sweden. Other countries not listed, excluding the US, comprise over €674 billion. As of 2014, the US had €4 billion outstanding in covered bond debt.

In Table 21.3, we show the amount of covered bond issuance by top issuing country for the years 2011–14. Denmark dominated covered bond issuance with almost €160 billion in average issuance for the four-year period. Global covered bonds issuance was substantially down (by approximately 40%) in 2013 relative to 2012. However, issuance appears to have stabilized in 2014.[56]

[54] Adrian Coles and Judith Hardt, "Mortgage Markets: Why US and EU Markets Are So Different." Available at <http://www.housingfinance.org/uploads/Publicationsmanager/Europe_coles_hardt.pdf>.

[55] European Covered Bond Council.

[56] ECBC, *2015 ECBC European Covered Bond Fact Book*, 516.

Table 21.2 Mortgage covered bonds outstanding in million Euros as of 2014

Top Six	
Denmark	369,978
Spain	282,568
Sweden	209,842
Germany	189,936
France	188,925
United Kingdom	130,797
Others[1]	674,588
United States	4,000
Total:	**2,050,634**

Note: [1]Includes Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Finland, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Luxembourg, Netherlands, New Zealand, Norway, Panama, Poland, Portugal, Slovakia, and Switzerland.

Source: Data are from 2015 ECBC Fact Book.

Table 21.3 Issuance of mortgage covered bonds in million Euros

	Mortgage Covered Bonds Issuance in Million Euros				
	2011	2012	2013	2014	Average
Top Six					
Denmark	145,147	185,845	149,989	154,310	158,823
Sweden	69,800	48,936	51,633	48,424	54,699
Spain	72,077	98,846	22,919	23,038	54,220
France	84,416	49,260	19,637	14,483	41,949
Italy	29,261	70,768	24,520	39,475	41,006
Germany	40,911	38,540	33,583	29,145	35,545
Others[1]	166,446	169,397	88,968	109,217	133,507
Total:	**608,058**	**661,592**	**391,249**	**418,092**	**519,748**

Note: [1]Includes Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Finland, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Luxembourg, Netherlands, New Zealand, Norway, Panama, Poland, Portugal, Slovakia, Switzerland, and the UK.

Source: Data are from 2015 ECBC Fact Book.

Jumbo Covered Bonds

There was a substantial change in the mortgage covered bond market after the issuance of "jumbo" or "benchmark" covered bonds. Since 1995, when the jumbo model was first introduced by a syndicate of banks in Germany, the jumbo model became the European standard for issuing of new covered bonds. The inception of the jumbo market also improved liquidity in the secondary covered bond market. This is due largely to bond standardization and listing on electronic platforms (however, OTC markets are still dominant).[57]

The principle features of the jumbo model are:[58]

(i) minimum issuance size (€1 billion);
(ii) plain vanilla bonds only (i.e., fixed coupon, bullet bonds);
(iii) at least five market makers are required to quote each other bid–ask prices for ticket sizes of up to €15 million;
(iv) the bond must be officially listed in an organized market (typically an electronic platform).

The jumbo covered bond market is the most actively traded segment, representing approximately half of the total covered bond market.[59]

The Case for Covered Bonds in the US

As the US housing bubble started to lose momentum in late 2006, default rates on mortgages increased such that by mid-2007, widespread defaults on subprime MBS threatened the stability of the non-agency mortgage market. Non-agency MBS, which had enjoyed tremendous market activity in prior years, started to become less attractive to investors and issuers alike. In large part, this was because of the apparent asymmetry in information—between investor, issuer, originator, and borrower—in connection with the quality of underlying collateral pools, created under the originate-to-distribute model.

By late 2007, it was clear that the subprime crisis had transformed into a global credit and liquidity crisis that was affecting all financial markets. Even agency MBS was affected, and the agencies themselves—Fannie Mae and Freddie Mac—began to experience difficulties in 2008. By September 2008, these companies were insolvent and had to be taken into conservatorship. Since then, there have been calls for a public policy that reduces the federal role in housing finance. With the private-label MBS market dramatically reduced in size relative to its peak in 2006, there has arisen a need for new funding mechanisms for the US housing market.

The Bank of America and Washington Mutual Issues

Specific covered bond programs for issuances in the United States so far consist of only BoA and WaMu. These covered bonds, which were issued in 2006 and 2007, provided test cases for (1) the appetite for covered bonds in the US and (2) how US covered bonds would withstand the extreme market volatility that characterized the credit crisis of 2007–9.

57 Avesani, Garcia Pascual, and Ribakova, "The Use of Mortgage Covered Bonds," 5.
58 Avesani, Garcia Pascual, and Ribakova, "The Use of Mortgage Covered Bonds," 5.
59 "Covered Bonds in the EU Financial System."

The 2006 WaMu covered bond offering was four times oversubscribed by European investors. However, the regulatory/legal constraints and lack of overarching statute meant that both US offerings had to use a costly, complex structure. As such, there has been no US-issued covered bond since 2007.[60] Because no formal legal framework exists to support the issuance of covered bonds in the US, generalizations regarding this market are limited to observation of the few covered bond issuances in the US to date.

In total, there were seven covered bonds issued from two US deals, totaling approximately $13.5 billion in face value. All the bonds had fixed-rate coupons with soft bullet maturities, which ranged from three to ten years. Of the seven bonds, six were Euro-denominated; the other was denominated in USD. At issuance, all the bonds were rated AAA by all three major US ratings agencies.[61]

Both the WaMu and Bank of America covered bond issues were issued into the European jumbo covered bond market and were issued by SPEs, which were legally separated from the banks themselves. This feature makes the two US issues somewhat akin to securitizations. Another feature that characterized the US issues was that the covered bond proceeds were used by the issuer to purchase the mortgage bonds. These mortgage bonds were then secured by a separate pool of mortgages that remained on the bank's balance sheet.[62] Both US issues also involved an overcollateralization account, such that the mortgage bonds exceeded the issued covered bonds in value.[63]

Because the US covered bonds were issued by SPEs, the bondholder does not have recourse to the credit institution itself. The US offers no special legislative framework that proscribes covered bond issuance, features, offering, and trading. Covered bonds follow the bankruptcy framework in place in the US.

In the US, the SPEs may contain pools of public-sector entity obligations, mortgage loans, and AAA-rated RMBS. Due to the short history of covered bond issuance in the US, covered bond programs are custom-designed to meet investor needs and do not yet comply with FDIC's Covered Bond Policy Statement[64] and the Best Practices for Residential Covered Bonds issued by the US Treasury in terms of disclosure regarding the covered bond asset pool.[65]

The structure of the two US covered bond issues differs fundamentally from those of typical deals in Europe. Being of a two-tiered structure, the US covered bond notes were secured by collateralized, bank-issued bonds—themselves secured by the cover pool, which remained on the banks' balance sheets. The banks granted a perfected security interest in the cover pool to a trustee, which was for the benefit of the SPE. Then, the SPE

[60] US Covered Bonds, "Basics of the U.S. Market."

[61] Information available from bond prospectus supplements.

[62] Pinedo, Marlatt, and Beck, "Frequently Asked Questions about Covered Bonds."

[63] Jay Surti, "Can Covered Bonds Resuscitate Residential Mortgage Finance in the United States?" *IMF Working Paper* (December 2010), 22.

[64] Federal Deposit Insurance Corporation, "Covered Bond Policy Statement" (July 15, 2008). Available at <https://www.fdic.gov/news/news/press/2008/pr08060a.html>.

[65] Henry M. Paulson, Jr., "Best Practices for Residential Covered Bonds," *U.S. Department of the Treasury* (July 2008). Available at <http://www.treasury.gov/about/organizational-structure/offices/General-Counsel/Documents/USCoveredBondBestPractices.pdf>.

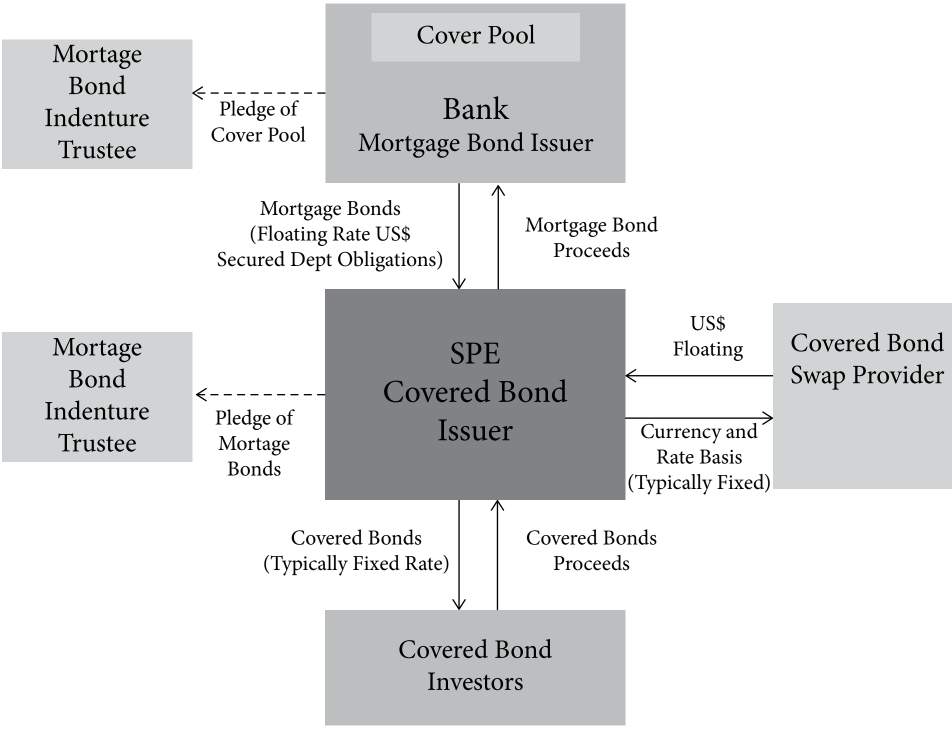

FIGURE 21.3 Structure of a US covered bond

Note: American Securitization Forum, "U.S. Covered Bonds: A Discussion Paper for the Federal Deposit Insurance Corporation," 5.

granted a perfected security interest in the collateral backing the covered bonds to a separate trustee, which was for the benefit of the covered bond investors.[66] A schematic of this structure is illustrated in Figure 21.3.[67]

In the US covered bond structure, the cover pool remains on the bank's balance sheet; however, the bank issues floating-rate mortgage bonds to the SPE, which in turn issues fixed-rate covered bonds to investors. Both interest rate and foreign exchange risk is hedged via swaps through a covered bond swap provider.

This US structure has various shortcomings and it is unlikely that it will be adopted for future US covered bond issuances. Part of the problem is that it is a complicated analogue of securitization such that the issuer is not a bank. Other problems are that over-collateralization levels are high and the structure is costly, in part due to the swaps needed to provide credit enhancement.[68]

Interestingly, non-US issuers have found investor diversification through US markets. There have been foreign offerings in the US market denominated in US dollars. The

[66] Winkler and Batchvarov, "Covered Bond Primer for the Uninitiated."

[67] American Securitization Forum, "U.S. Covered Bonds: A Discussion Paper for the Federal Deposit Insurance Corporation."

[68] Jerry Marlatt and Anna Pinedo, "Time for a US Alternative" (2013). Available at <http://media.mofo.com/files/Uploads/Images/130701-Covered-Bonds-Guide-Time-for-US-Alternative.pdf>.

viability of such foreign covered bond issuance, however, depends largely on currency swap rates. Between 2011 and 2013, swap rates were favorable for US dollar issuance. Since then, Euro-denominated issuance in Europe has been more favorable.[69]

The RBC Offering

In 2012, Canada's largest bank, RBC issued a $2 billion covered bond series that was registered with the SEC. Both the BoA and WaMu deals were issued either under Rule 144a or Reg. S, which may have limited their size and investor bases. The RBC deal may broaden the base of investors and bring greater liquidity to the US covered bond market. While future issuers may register covered bonds, however, there is a trade-off relative to private placement, in that registration takes more time and resources.[70]

Covered Bonds During the Credit Crisis

Issuance of covered bonds during the credit crisis does not appear to have been affected. In Figure 21.4, we show annual issuance for the top six issuing countries. While there is a

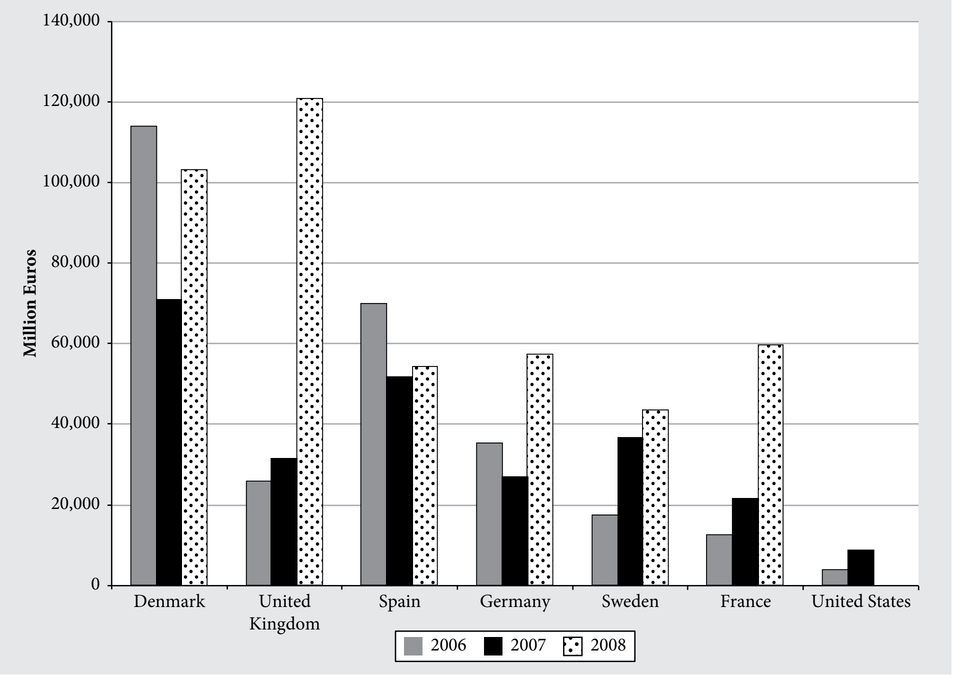

FIGURE 21.4 Comparison of mortgage covered bond issuance for the top six issuing countries and US, 2006–8

Source: Data are from 2015 ECBC Fact Book

[69] US Covered Bonds, "Basics of the U.S. Market."

[70] Barry Critchley, "RBC's Covered Bond Issue a Little Piece of History," *Financial Post* (September 12, 2012).

reasonably wide variance in average issuance among countries for the period 2006–8, there does not appear to be a consistent, within-country trend. This suggests that the market for covered bonds remained strong while global credit markets were extremely volatile. (As reference, we have placed the US covered bond issuance levels for 2006 and 2007 on the chart.)

Yield Spreads

As with all non-Treasury securities, covered bonds suffered some degree of spread widening and volatility during the credit crisis. Relative to MBS and even corporate debt, these effects were largely localized in time. Furthermore, the extent of the covered bond spread widening was limited compared to both non-agency MBS and corporate debt.

In Figures 21.5 and 21.6, we have plotted the yield spreads of each of the Euro-denominated covered bonds throughout the period 2007 through 2009, for the BoA and the WaMu covered bond programs. We have also plotted the yield spreads of a BoA and WaMu corporate issuance and the Boston FHLB advance rate, for reference.

WaMu's deteriorating credit quality from August 2007 to December 2008 raised the spreads on both the bank's unsecured debt and its covered bonds. The dual-recourse structure of the covered bonds made them less sensitive to the risk of issuer default;

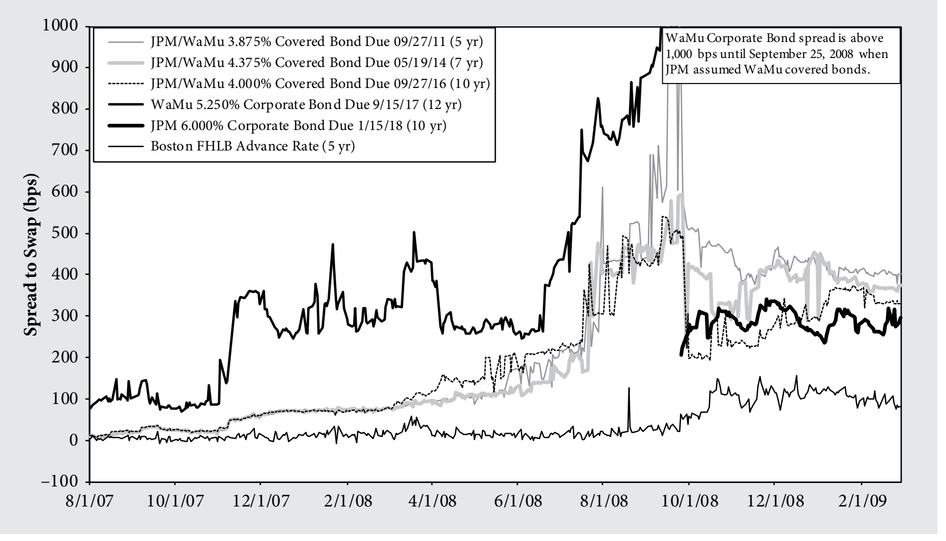

FIGURE 21.5 Yield spreads of WaMu/JP Morgan covered bonds vs corporate debt performance during the financial crisis

Notes: 1. Yield to swap is calculated as the mid-yield to maturity less the swap rate for banks with matched maturities.
2. The US dollar swap rate is used for all USD-denominated benchmarks: Boston FHLB Advance Rate (5 yr), JPM 6.000% Corporate Bond due 1/15/18 (10 yr), and WaMu 5.250% Corporate Bond due 9/15/17 (12 yr). The Euro swap rate is used for all other bonds and benchmarks.
3. On September 25, 2008, JP Morgan acquired Washington Mutual.

Source: The figure is a reproduction of Figure 8-7 in the *Covered Bonds Handbook*, Volume 1, Incorporating Release #4 (2014). Used with permission from the Practising Law Institute.

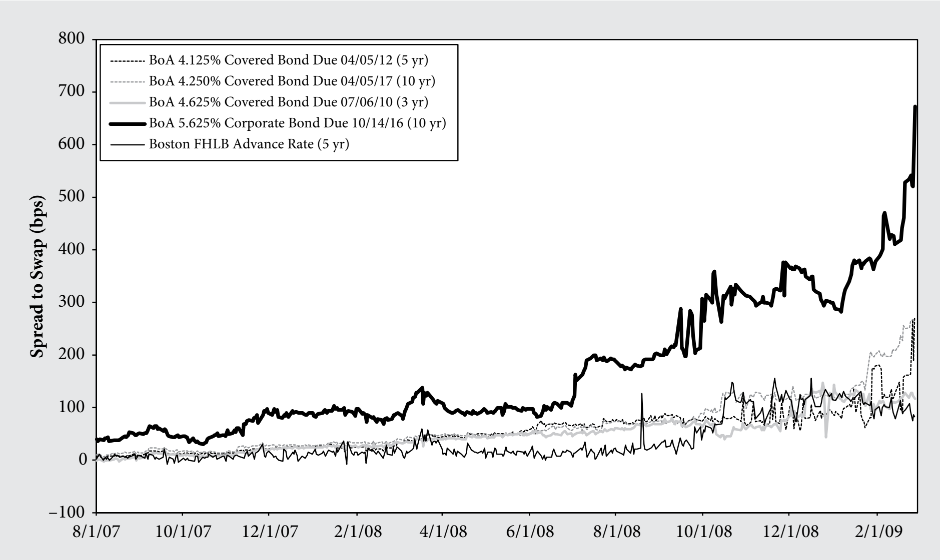

FIGURE 21.6 Yield spreads of BoA covered bonds vs corporate debt performance during the financial crisis

Notes: 1. Yield to swap is calculated as the mid-yield to maturity less the swap rate for banks with matched maturities.
2. The US dollar swap rate is used for all USD-denominated benchmarks: Boston FHLB Advance Rate (5 yr) and BoA 5.625% Corporate Bond due 10/14/16 (10 yr). The Euro swap rate is used for all other bonds and benchmarks.

Source: The figure is a reproduction of Figure 8-6 in the *Covered Bonds Handbook*, Volume 1, Incorporating Release #4 (2014). Used with permission from the Practising Law Institute.

hence, their spreads did not widen to the same extent as the straight corporate debt, as illustrated in Figure 21.5.[71]

A similar pattern is observed for the BoA covered bonds relative to the BoA straight corporate issue. While covered bond spreads did widen throughout 2008 and early 2009 relative to the FHLB rate, the effect was minor relative to that of the straight corporate debt. The difference, as seen in Figure 21.6, reflects the dual-recourse nature of the covered bonds, which is absent in straight corporate debt.

Bid–Ask Spreads

It can be argued that the subprime crisis, which started at the end of 2006, transformed into a liquidity/credit crisis by August 2007. It was at this time that Moody's Investors Service downgraded 691 MBS, the asset-backed, commercial paper market froze, and the Federal Reserve Bank of New York said it would buy a total of $62 billion in mortgage-backed, Treasury, and agency securities to provide liquidity for the banking system.

Bid–ask spreads, which are a standard proxy for liquidity, tended to increase for many non-Treasury debt instruments throughout the credit crisis. In Figure 21.7, we show

[71] *Covered Bonds Handbook*, Volume 1, Incorporating Release #4, Practising Law Institute (2014), ch. 8, p. 15.

	4/17/2007 to 8/16/2007		8/17/2007 to 12/17/2007		
	Average Bid-Ask Spread	Number of Observations	Average Bid-Ask Spread	Number of Observations	Change in Spread
	(1)	(2)	(3)	(4)	(5) (3)–(1)
Covered Bonds					
BoA 4.25%–2017 (€)	0.118	87	0.175	87	0.058
BoA 4.125%–2012 (€)	0.082	87	0.100	87	0.018
BoA 4.625%–2010 (€)	0.051	34	0.077	87	0.026
WaMu 3.875%–2011 (€)	0.077	87	0.105	87	0.028
WaMu 4.000%–2016 (€)	0.085	86	0.164	87	0.079
WaMu 4.375%–2014 (€)	0.091	67	0.156	87	0.065
Deutsche Pfandbriefbank AG 3.750%–2013 (€)	0.062	21	0.109	87	0.046
Corporate Bonds					
BoA 4.875%–2012 ($)	0.521	88	1.287	87	0.766
BoA 4.375%–2010 ($)	0.451	87	1.515	81	1.065
BoA 5.625%–2016 ($)	0.812	88	1.871	85	1.060
WaMu 4.200%–2010 ($)	0.811	78	2.890	2	2.079
WaMu 5.500%–2011 ($)	0.551	21	3.210	4	2.659
WaMu 5.250%–2017 ($)	1.176	77	5.896	10	4.720

FIGURE 21.7 Average bid–ask spread of WaMu and BoA bonds in 2007

Source: The figure is a reproduction of Figure 8-8 in the *Covered Bonds Handbook*, Volume 1, Incorporating Release #4 (2014). Used with permission from the Practising Law Institute.

for two distinct periods during 2007, the average, absolute bid–ask spreads of the Euro-denominated, US covered bond issues, relative to those of the corporate debt of the issuing institutions. Also shown for reference is a representative Pfandbrief.

Prior to August 17, 2007, when the Fed cut the overnight lending rate by 50 basis points, the US-issued, Euro-denominated covered bonds had average bid–ask spreads that ranged from about 0.05 to 0.12. The highly liquid Pfandbrief had a bid–ask spread of 0.06, while corporate bonds had bid–ask spreads that ranged from 0.45 to 1.18. During the period after the Fed's announcement on August 17, spreads widened across all products. However, the impact on the corporate debt was substantially more pronounced. Indeed, the relative stability of covered bond liquidity during 2007, as captured by the bid–ask spreads, was comparable to that of the Pfandbrief rather than the straight corporate bonds.[72]

Ratings

Covered bonds exhibit remarkably stable credit ratings over time. In the years after the credit crisis, MBS suffered a high degree of downgrades by all three major US ratings agencies. In Table 21.4, we illustrate the ratings stability of covered bonds (rated by S&P) as of 2012, relative to the ratings stability of prime (jumbo) MBS as well as Alt-A and subprime MBS.

The percentage of bonds, within the three MBS categories, that experienced downgrades in 2012 ranged between approximately 40% to 45%. In contrast, only about 12% of covered bonds were downgraded by S&P in 2012. As already discussed, no covered bond has ever defaulted. In 2012 alone, however, the percentage of MBS defaults across the three categories ranged from approximately 9% to 24%.

[72] *Covered Bonds Handbook*, Volume 1, Incorporating Release #4, Practising Law Institute (2014), ch. 8, p. 28.

Table 21.4 Ratings transitions of mortgage products in 2012

Subsector	# of Observations	Stable (%)	Upgrade (%)	Downgrade (%)	Near default (%)	Default %
Alt-A	2,699	51.65	3.37	44.98	2.07	24.49
Prime	6,860	50.07	5.15	44.78	3.28	9.34
Subprime	8,404	58.37	1.93	39.71	2.26	14.11
Covered Bonds	485	87.01	0.62	12.37	0	0

Source: Data are from table 7 in S&P, "Global Structured Finance Default Study, 1978–2012: A Defining Moment For Credit Performance Stability."

Implications for Mortgagors

Because covered bonds generally involve pools of mortgages that are held on the books of the issuing bank, it is in the best interest of the bank to originate or purchase mortgages originated with lower-risk profiles than those that might arise out of the originate-to-distribute model. This suggests that LTV and FICO requirements for cover pool loans should generally be more stringent than those in MBS, in particular non-agency MBS. Because the agencies guarantee the MBS they issue, one expects that, with the exception of certain affordability programs, such a discrepancy in underwriting standards would not be evident with Fannie Mae and Freddie Mac loan pools as compared to European cover pools.

In the case of MBS, it is believed that the mortgagor enjoys the lowest possible rates due to the increased availability of financing through securitization. While covered bonds are technically not a securitization, they too should reduce the cost of borrowing by expanding the investor base, but possibly not to the same degree.

Covered bonds as a major mortgage funding vehicle in the US would likely provide a strong incentive to originators for prudent underwriting. However, the issuer's capital outlay required to fund mortgages through covered bonds is greater than with securitization in an originate-to-distribute model. This is true in both the agency and non-agency markets. The result would be that this increased cost of capital is passed on to the homebuyers. So, there would appear to be a trade-off between mortgage funding for the borrower and sound underwriting, if covered bonds gained traction in the US.[73]

An important difference exists between US and European primary mortgage markets. In the US, the 30-year, fixed-rate mortgage dominates origination, comprising the majority of new originations as well as outstanding mortgages.[74] This product is unique

[73] Surti, "Can Covered Bonds Resuscitate Residential Mortgage Finance in the United States?" 6.

[74] Emanuel Moench, James Vickery, and Diego Aragon, "Why Is the Market Share of Adjustable-Rate Mortgages So Low?" *Federal Reserve Bank of New York: Current Issues in Economics and Finance*, 16/8 (December 2010), 1–11.

to US primary markets and facilitates the issuance of fixed-rate MBS with 30-year maturities. In the case of fixed-rate mortgages, the prepayment risk is transferred to the investor, who is compensated through additional spread.

Adjustable-rate mortgages are also common in the US, but have historically been in the minority. With the extremely low interest rates in recent years, adjustable-rate mortgages are less popular than ever, comprising only 7% of mortgage originations in 2015.[75] In Europe, however, the adjustable-rate mortgage (or a hybrid product that converts to adjustable rate after a fixed period) is the prevalent product.[76] This reduces the prepayment risk (retained by the issuer in the case of covered bonds) because one of the main drivers of prepayments is the interest rate incentive associated with fixed-rate mortgages.[77] Also, in European countries offering fixed-rate products, there are typically penalties that serve to curb prepayments. While typical US mortgages are fixed-rate, prepayment penalties are not the norm. This factor would need to be considered when using US mortgages as covered bond collateral.

Legislation

There exists extensive legislation across European countries that sets forth definitions, supervision, cover pool provisions, lending limits, etc. To date, no such legislation is currently in place in the US. This uncertainty as to legal issues surrounding how covered bonds should function is a major obstacle that inhibits the development of a viable covered bond market in the US. There have, however, been some attempts to put such legislation into effect. Moreover, both the FDIC and the Fed have publicly commented on covered bonds, thereby eliminating some of the uncertainty that shrouds covered bonds in the US.

The United States Covered Bond Act of 2011

US Representative Scott Garrett of New Jersey introduced the United States Covered Bond Act of 2010 and later the United States Covered Bond Act of 2011, intended to provide a legislative framework that facilitates the flow of credit from the capital markets into households, small businesses, and governments. The framework, which is supported by SIFMA, is designed to stabilize the financial system and provide legal certainty for covered bond programs and public supervision by federal regulators.[78]

The bill (which has had several incarnations as H.R. 4884, H.R. 5823, and H.R. 940) contemplates the establishment of an oversight program for covered bonds. In particular,

[75] Mortgage Bankers Association.

[76] Lea, *International Comparison of Mortgage Product Offerings*, 17–20.

[77] See, for example, Lakhbir Hayre and Robert Young, "Anatomy of Prepayments: The Salomon Smith Barney Prepayment Model," in Lakhbir Hayre (ed.), *Salomon Smith Barney Guide to Mortgage-Backed and Asset-Backed Securities* (New York: John Wiley & Sons, 2001), ch. 4.

[78] Andrew DeSouza, "SIFMA Supports United States Covered Bond Act of 2011," SIFMA Newsroom (May 3, 2011).

the bill specifies that federal banking regulators or the Treasury should act as covered bond regulators, depending on the issuer. Also, there is explicit language as to the treatment of covered bonds in the event of bank failures.[79]

The main areas of the legislation cover topics such as regulatory oversight, eligible asset classes, issuer eligibility criteria, and topics related to how the cover pool is treated in the event of a default. The general aim of the legislation is to remove uncertainties associated with US covered bonds, especially regarding the treatment of the cover pool in the event of an issuer failure.[80]

While there has been substantial progress as far as advancing the topics in the bill, there remain several unresolved issues: especially concerning the role of the FDIC in the event of an issuer bankruptcy.[81]

FDIC and Covered Bonds

There are no regulatory prohibitions on the issuance of covered bonds by US banks. In order to reduce market uncertainty, therefore, the FDIC has issued an Interim Policy Statement to provide clarity and guidance on the investors' claims to the cover pool, should the issuing entity fail. While the Policy Statement imposes no new obligations on the FDIC as conservator or receiver, it defines the specific circumstances under which the FDIC allows for the expedited access to the cover pool.[82]

In the event that an issuing bank becomes insolvent, investors have the first claim on the covered pool. This in turn means that the federal government takes on a portion of the default risk associated with covered bonds because the securities have priority over the FDIC. So, to the extent that banks begin to use covered bonds as a means of increasing lending or replacing uninsured deposits, FDIC's risk is increased. Therefore, regulators have effectively limited covered bonds to 4% of a bank's total liabilities.[83]

Fed's View on Covered Bonds

After engaging in discussions with market participants, the US Treasury concludes that a covered bond framework could attract investor interest and generate increased access to mortgage credit. The Treasury notes that "[h]igh-quality assets might be financed if banks are allowed to manage pools of loans, substituting new loans into the pool as others become delinquent. Newly issued covered bonds backed by high quality mortgage loans and issued by strong financial institutions may find a growing investor base in the United States."[84]

[79] Edward V. Murphy, "Covered Bonds: Background and Policy Issues," *Congressional Research Service* (April 26, 2013).

[80] "Structured Finance in Focus: A Short Guide to Covered Bonds."

[81] Deborah M. Higgins, "Covered Bonds: What's Happening Now?" (January 29, 2015). See slide 22.

[82] Federal Deposit Insurance Corporation, "Covered Bond Policy Statement" (July 15, 2008). Available at <https://www.fdic.gov/news/news/press/2008/pr08060a.html>.

[83] "Alternative Approaches for the Future of the Secondary Mortgage Market," 48.

[84] Kevin Warsh, "Remarks on Covered Bond Framework" (July 28, 2008). Available at <http://www.federalreserve.gov/newsevents/speech/warsh20080728a.htm>.

As collateral for funding, the Federal Reserve has traditionally accepted a wide range of high-quality assets from depository institutions. Consistent with this policy, the Federal Reserve has stated that highly rated, high-quality covered bonds fall within guidelines as eligible collateral.[85]

Key Points

- Covered bonds have been around for over 240 years.
- Covered bonds have features of both MBS and secured corporate debt.
- Unlike MBS, underlying mortgages in a covered bond remain on the issuer's balance sheet.
- Covered bonds are one of the primary sources of mortgage funding in Europe.
- Due to government programs in place, covered bonds have not caught on in the US.
- There have been only two covered bond deals to date in the US.
- Architecture of US covered bonds involves an SPE.
- Covered bonds are generally issued with high ratings and are looked upon favorably by regulators.
- Covered bonds held up well during the credit crisis.
- US litigation is moving toward a clarification of how covered bonds will be treated in the US generally: especially regarding the treatment of the covered pool in the event of issuer default.

Acknowledgment

The authors acknowledge research assistance provided by Alvaro Morales, Luke Li, and Dennis Chu.

[85] Warsh, "Remarks on Covered Bond Framework."

PART V

COMMERCIAL MORTGAGE-BACKED SECURITIES

CHAPTER 22

AGENCY COMMERCIAL MORTGAGE SECURITIES

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After reading this chapter you will understand:

- the definition of the agency commercial mortgage-backed securities (ACMBS) market;
- the history of the three major programs of the ACMBS market:
- ginnie Mae, Fannie Mae, and Freddie Mac securities;
- how ACMBS origination volume surged after the recession of 2007–9;
- the underwriting criteria and default history of each of the three major ACMBS programs;
- the differences in the US government backing of the three major ACMBS programs;
- the differences in the trading values among the three major ACMBS programs;
- how ACMBS fits into a mortgage securities investment portfolio.

The agency commercial mortgage-backed securities market (ACMBS) includes many different types of US government programs where the underlying assets are commercial real estate, primarily multifamily and some health care properties. ACMBS bonds either have an explicit US government guarantee or are guaranteed by one of the government-sponsored enterprises (GSEs). ACMBS bonds all have solid call protection on the underlying loans, and they have 10-year final maturities and/or 10-year refinancing horizons.

This chapter will focus on the three primary ACMBS programs: Ginnie Mae Project Bonds, Fannie Mae DUS Bonds, and Freddie Mac Multifamily K-Series bonds. All three of these ACMBS programs have been active for many decades. ACMBS issuance has increased since the recession of 2008–9, as these three programs expanded greatly to fill the void left by private commercial real estate lenders. Outstanding ACMBS volume across these three securities programs stood at over $315 billion as of year-end 2014.

The depth and liquidity of the ACMBS market, coupled with the call protection and shorter maturities of these programs, sets ACMBS apart from the residential agency securities markets, and makes ACMBS attractive to many fixed-income investors.

Ginnie Mae Project Securities

From its inception in 1968, Ginnie Mae (GNMA) has wrapped Federal Housing Administration (FHA)-insured multifamily loans as well as single-family loans. Since the National Housing Act of 1934, as amended, one of the primary goals of the FHA has been to enhance the nation's supply of multifamily housing. Over the years, several FHA programs have evolved to provide federal insurance for the construction, rehabilitation, permanent financing, and refinancing of many types of multifamily residences (including rental apartments, condominiums, cooperatives, and elderly housing), as well as on healthcare facilities such as nursing homes, assisted living facilities, and on hospitals. GNMA wraps qualifying loans under these FHA multifamily programs, in the same way the agency wraps qualifying single-family FHA and VA loans.

GNMA's multifamily bonds have prepayment characteristics that are very different from single-family GNMA bonds. While single-family GNMAs are backed by numerous smaller FHA mortgages, GNMA project bonds are backed by one larger FHA mortgage loan. Importantly, unlike single-family residential loans, GNMA's multifamily bonds are originated with formal call protection, permitted for a maximum of ten years by the FHA, and also exhibit reasonably consistent refinancing horizons of ten to twelve years. These distinctions mean that GNMA multifamily bonds can provide useful additions to mortgage bond portfolios.

GNMA Origination Trends

Since 2002, GNMA multifamily originations have increased steadily, culminating with a record $28.3 billion in GNMA multifamily and healthcare originations in the agency's fiscal year 2013 (November 1, 2012 to October 31, 2013). This steadily increasing origination volume reflects not just macro trends like favorable interest rates and meaningful increases in property values, but also micro trends, including continuing efficiencies at the FHA, the guarantor of the underlying project loan, as well as the positive effects of GNMA's multifamily REMIC program (see next section).

For the fiscal year 2014 (November 1, 2013 to October 31, 2014), GNMA multifamily and healthcare originations came in at $17.8 billion, while for fiscal year 2015 (November 1, 2014 to October 31, 2015) GNMA originations came in at $21.5 billion. While the last two years are down from GNMA's record origination volume in 2013, they are in line with GNMA's recent multifamily and healthcare origination volume, which has averaged

$21.6 billion per year over each of the past five years. Regarding the total volume of GNMA multifamily bonds issued and outstanding, GNMA's total insured portfolio stood at $94.4 billion as of October 31, 2015.

GNMA's Multifamily REMIC Program

GNMA expanded its REMIC shelf to include multifamily projects in February 2001. Since the first multifamily GNMA REMIC was completed (GNR 2001–12), GNMA multifamily REMIC issuance has expanded dramatically each successive year. By 2004, virtually all GNMA multifamily originations were used as collateral for REMICs. This increased REMIC issuance easily absorbed the gradual growth in GNMA origination volume over the past twelve years, with the result that spreads on GNMA originations have trended tighter each year (albeit with one or two intra-year rate shifts). In turn, ever-tightening spreads helped increase GNMA originations, as lower rates and tighter spreads made GNMA financing increasingly attractive to borrowers. Of course, the "feedback loop" continued, as increased originations served to increase GNMA REMIC issuance, augmenting the liquidity of GNMA REMICS and so further tightening bond spreads and in turn, origination spreads.

During the 2013 record highs in GNMA multifamily originations, GNMA REMIC issuance also reached a high point. In 2013, $21.8 billion of GNMA multifamily REMICS came to market (net of Re-Remics); REMIC securitizations were completed by eleven separate Wall Street dealers in 2013 (another high-water mark). In 2014, GNMA REMIC volume was down slightly, but still came in at $18.8 billion, with REMICs completed by ten separate Wall Street dealers. In 2015, GNMA REMIC volume was down, and came in at $15.5 billion, with REMICs completed by eight separate Wall Street dealers. Considering that GNMA's hospital bonds are not eligible for REMICS, that Risk-Sharing GNMA issuance is generally funded in the municipal bond market, and that only partial draws of GNMA construction bonds are included in many REMICs, substantially all eligible GNMA originations were securitized in GNMA REMICs in 2013. Of course, the result was continued spread tightening of GNMA bond collateral in 2013.

GNMA Multifamily Prepayments

GNMA projects do not trade to estimates of prepayment speeds like single-family mortgage-backed securities. As noted above, GNMA projects are issued with formal contractual prepayment protection, which is limited by the agency to a maximum of ten years. GNMA projects tend to prepay after the call protection expires, in years ten to twelve.

The most important asset in a multifamily property business is the rent roll. The liabilities are expenses, and by far the primary cost is debt service on the mortgage. Net operating income (NOI) for a multifamily property equals rent payments received minus mortgage costs and operating expenses. The business's primary cost, mortgage debt service, is locked in at a fixed rate for an extended period of time. However, the assets of a real estate business are dynamic, since rent payments tend to increase each year. For example, even a 2% annual rent increase, which is at the very lower end of historical rent growth, compounds over the years to generate significantly more NOI after ten to twelve years.

In turn, that increased NOI underwrites to a larger mortgage and can also support a higher interest rate on the new mortgage. Multifamily borrowers often refinance to capitalize this NOI, using proceeds to refurbish fixtures like stoves, refrigerators, etc., while also taking out equity and often leveraging that equity to purchase another multifamily rental property.

In addition to the refinancing incentives that increases in NOI can provide, tax-related issues can also provide incentives for multifamily property owners to refinance. Many multifamily properties are owned by a primary owner/operator, with one or two limited partners. All the partners receive the tax benefits associated with the depreciation of the property, but typically depreciation is more important to the limited partners. As the mortgage amortizes, the value of the depreciation erodes, particularly by ten to twelve years after the loan was made. Partners can benefit from refinancing at that point, thereby resetting the depreciation schedule.

Both NOI growth and the tax benefits of depreciation are standard strategies for multifamily borrowers, which is why Fannie Mae, Freddie Mac, conventional CMBS conduit lenders, banks, and insurance company lenders underwrite billions of multifamily loans every year with 10-year balloon maturities.

Prepayments and GNMA REMICs

In the single-family market, GNMAs are of course backed by FHA/VA loans, and the FHA/VA are the lenders of last resort, providing borrowers more leverage than other agencies and lenders. Similarly, the FHA loans that back GNMA's project program also offer borrowers greater leverage than other agencies and other lenders. Greater leverage is central to the charter of the FHA in both single-family and multifamily finance; the FHA is required to fulfill their statutory mandate to provide capital to low- and moderate-income borrowers.

As a result of this greater leverage, defaults on GNMA projects have been consistently higher than on Fannie Mae, Freddie Mac, bank, and insurance company multifamily originations. The long-standing prepayment convention for GNMA multifamily REMICs recognizes the potential for defaults. Since the earliest GNMA multifamily REMICs, 15 CPJ has been the pricing convention for GNMA REMICs. 15 CPJ is defined as 0 CPR during any lockout on the underlying loans, then 15 CPR after any lockout; simultaneously 15 CPJ also vectors in a default curve over and above the 15 CPR, which is known as the Project Loan Default (PLD) curve. The PLD curve starts when the underlying GNMA is first originated, averages just over 2% per year for each of the first five years, and then drops significantly.

Much research supports the 15 CPJ prepayment convention, including the PLD component of project prepayments. That said, as REMIC issuance has exploded over the past three years, investors need to evaluate all factors that generate prepayments in multifamily projects. While older GNMA REMICs have consistently prepaid at or around the 15 CPJ convention, many of the REMICs done over the past few years are backed by GNMAs that were originated at or near historically low interest rates. While NOI growth and tax depreciation remain the operative drivers of GNMA prepayments, many observers feel that the refinancing time horizon may extend somewhat on the low-coupon collateral originated over the past few years, particularly during the record low interest rates of 2012 and early 2013 (with sub-2% 10-year US Treasury rates). Also, in response to the economic upheavals of 2007–9, the FHA tightened its underwriting guidelines and made reductions in the leverage the agency will provide to multifamily properties. FHA/GNMA multifamily loans still offer greater leverage than any other lenders, and so defaults can still be expected. But since these more conservative underwriting guidelines have been permanent since 2009, it is no longer clear that the full PLD default curve component of the CPJ prepayment convention will be realized on newer GNMA originations, particularly recent GNMAs originated at low interest rates.

GNMA Programs Facilitate Refinancing

The FHA and GNMA have long recognized the tendency for multifamily bonds to refinance based on growth in NOI and, to a lesser extent, depreciation. In response, over the years the agencies have steadily increased the number of products they offer for owners to refinance their existing FHA/GNMA-financed properties.

Section 223(f)

As long ago as 1974, FHA/GNMA rolled out their first program for refinances by expanding Section 223(f) of the National Housing Act to include refinances as well as new purchases. Section 223(f) refinancing capability was added in response to private-sector demand for an FHA/GNMA-insured refinancing vehicle, as well as to preserve an adequate supply of affordable housing. Conventionally financed multifamily and healthcare properties, as well as existing FHA/GNMA-insured projects issued under sections of the National Housing Act, can be refinanced under Section 223(f). Subject to FHA underwriting, borrowers refinancing existing FHA/GNMA mortgages are able to take out equity from the project, and can also extend the maturity of the new 223(f) mortgage out to the loan's original term. For example, if the original FHA/GNMA mortgage had a 480-month term, but had amortized nine years to a 372-month term, the new 223(f) mortgage could reset to a 480-month term, reducing monthly P&I payments for borrowers. To qualify for insurance under Section 223(f), a project must be at least three years old, must contain five or more units, and must have sufficient occupancy to pay annual debt service, operating expenses, and maintain a reserve fund for repairs. Given the potential for equity takeout, maturity extension, and project expense reverification, it does take some time for the FHA to underwrite and approve a refinancing under Section 223(f), and borrowers have to wait until the underwriting process is complete. Nevertheless, as the first refinancing vehicle offered by FHA/GNMA, Section 223(f) has been successful. By 1999, only 15 years after the program began, 223(f) issuance was up to $19.4 billion, which represented 26% of the $74 billion FHA/GNMA multifamily universe at that time.

Section 223(a)7

Section 223(a)7 was expanded primarily to address the length of time it takes the FHA to underwrite a refinancing under the 223(f) program. As stated above, primarily as a result of the equity takeout and maturity extension available under 223(f), the FHA takes care and time in the underwriting and approval process. In response, FHA/GNMA expanded the 223(a)7 program in late 1993, and began approving refinances under the new procedures in 1994. Under Section 223(a)7, refinances are limited only to existing FHA/GNMA-insured properties; no conventionally financed projects are eligible, as they are under Section 223(f). In addition, under 223(a)7 the maturity is limited to the unexpired term of the current mortgage plus twelve years; borrowers cannot extend the project's maturity, as they can under 223(f). Section 223(a)7 permits the new mortgage amount to be reset to the original mortgage amount, enabling the borrower to capitalize the amortization of the original mortgage; however, any equity released under Section 223(a)7 must be used exclusively for property upgrades and improvements at the project. As a result of these constraints, the FHA accelerates the underwriting process, and waives a new appraisal in favor of relying on the most recent audited financials of the project. Consequently, while underwriting and processing time under Section 223(f) can take four to six months, under 223(a)7 that timeframe is reduced to about three months.

Interest Rate Reduction Program

During the low interest rates of 2012–13, private-sector borrowers and FHA/GNMA mortgage origination companies pressed the agencies to complete refinances even faster than the few months it takes to complete a 223(a7) refinancing. In response, FHA and GNMA introduced the Interest Rate Reduction (IRR) program in March 2013. The IRR program permits existing FHA/GNMA borrowers to modify their loan into a lower interest rate. There is no equity takeout nor re-amortization permitted; the IRR program simply lowers the interest rate on the existing mortgage. The agencies realize that by modifying the interest rates lower it benefits properties and thus also reduces the agencies' insurance exposure. Since no changes are permitted in the mortgage, FHA and GNMA do not re-underwrite. Consequently, IRR modifications can be completed within four to six weeks.

The IRR program has proved to be very popular with borrowers and GNMA mortgage originators. Just 18 months into the program (as of FHA/GNMA's FY 2014, which ended September 30), 514 loans were modified and reissued at lower interest rates under the IRR program. By December 2014, another 320 IRR were being processed by GNMA and expected to close and refinance in early 2015.

GNMA Refinancing Programs: Summary

These three refinancing programs have come to dominate GNMA multifamily originations. As of December 2014, fully 75% of the bonds within GNMA REMICs were refinances under one of these three FHA/GNMA programs, which is significant since the vast majority of GNMA multifamily bonds have ended up in REMICs for years. Over the recent past, low interest rates have contributed to the FHA/GNMA refinancings, but the FHA/GNMA responses to the marketplace with these increasingly efficient refinancing loan products are the main drivers of the agencies' success with refinancings.

Fannie Mae Multifamily DUS

Fannie Mae (FNMA) has been providing multifamily financing through its network of Delegated Underwriting and Servicing (DUS) lenders for over 25 years. In 1988, FNMA began purchasing DUS loans and holding them in portfolio; in 1994, FNMA began issuing securities backed by individual DUS loans.

Under the DUS program, FNMA delegates the underwriting, closing, and sale of FNMA DUS securities to a group of FNMA-approved lenders (25 at present). DUS lenders must abide by FNMA's credit and underwriting criteria, are reviewed and monitored by FNMA, including regular credit audits, and must maintain capital in proportion to their origination and servicing volume. In addition, FNMA DUS is a risk-sharing program; DUS lenders share in any credit losses with FNMA. This loss sharing is an added incentive for DUS lenders to monitor and manage credit exposure actively. Defaults on FNMA DUS bonds are rare. FNMA releases 60-day delinquency data for the FNMA DUS program. Since 2006, 60-day delinquencies have averaged just over 25 basis points, which includes a spike up to 75 basis points in late 2009, at the height of the recession. For many earlier years, and for the past three years, 60-day delinquencies have been 10 basis points or less.

DUS bonds are most commonly backed by one loan, and have standardized features. By far the most common structure is a 10-year balloon maturity with a 30-year amortization schedule and prepayments subject to 9.5 years of yield maintenance ("10/9.5"). While some FNMA DUS bonds do have shorter or longer maturities, the 10/9.5 structure represents over 80% of FNMA DUS originations year after year. In ACMBS, as well as in conventional CMBS programs, yield maintenance (YM) permits a borrower to prepay the loan only if the YM payment is made. YM is based on a UST index closest to the YM term of the bond. Thus the YM fee increases when interest rates drop and Treasuries rally, deterring refinancing and therefore limiting negative convexity. FNMA does permit defeasance, which allows borrowers to prepay the loan by substituting US Treasury strips/securities which match the cash flow of the DUS bond, which also limits negative convexity.

FNMA requires DUS lenders to use the following three-tiered credit structure to underwrite DUS bonds, low to high Tier 2, Tier 3, and Tier 4:

Minimum	Maximum	
Rank	DSCR	LTV
Tier 2	1.25	80%
Tier 3	1.35	65%
Tier 4	1.55	55%

Tier 2 bonds represent roughly two thirds of all FNMA DUS issued. Tiers 3 and 4 DUS loans offer less leverage to borrowers; in turn, FNMA reduces its guarantee fee accordingly.

As a GSE, FNMA cannot offer an explicit US government guarantee for FNMA DUS bonds. FNMA is responsible for making principal and interest payments under its guarantee, and for repaying the entire outstanding principal balance to investors at maturity. Just as in FNMA's single-family bonds, DUS bonds carry FNMA's guarantee of timely payment of principal and interest. FNMA has never missed a scheduled payment of principal and interest on any of its mortgage-backed securities, single-family or multifamily DUS.

FNMA is the largest provider of multifamily capital among the three major ACMBS programs. As of December 31, 2013 FNMA DUS issued and outstanding stood at $187 billion. Fannie Mae's DUS issuance is subject to caps, although DUS bonds backed by affordable properties are exempt from this cap. In 2013, FNMA DUS issuance was 28.5 billion; in 2014, FNMA issued 28.6 billion DUS bonds, while in 2015, FNMA DUS issuance increased to 42.3 billion.

FNMA DUS bonds typically trade as individual bonds, backed by one loan. Individual DUS bonds can be pooled together; such pools are referred to as FNMA Mega pools. More commonly, larger pools of DUS bonds are pooled and structured in DUS REMICs by Wall Street dealers and issued on the FNMA's ACES (Alternative Credit Enhancement Securities) shelf. FNMA also pools DUS bonds and issues REMICs as Fannie Mae

GeMS (Fannie Mae Guaranteed Multifamily Structures). For investors, there is no difference between an ACES or a GeMS DUS REMIC other than the party aggregating the FNMA DUS collateral.

Freddie Mac Multifamily K Series Bonds

Freddie Mac (simply Freddie hereafter) has been a portfolio lender for mortgages since its founding in 1970. By 1993, Freddie Mac had expanded into multifamily lending by establishing its Program Plus lending platform. Freddie maintains a network of approved Program Plus Seller/Servicers (29 at present) to originate multifamily loans on a prior-approval basis so long as the loans meet Freddie guidelines. Freddie Mac completes the underwriting and credit review of all multifamily mortgages in-house through regional offices as well as at its headquarters. There is no delegation of underwriting authority to lenders, and Freddie has the final say on which multifamily loans the agency will fund. This approach is consistent with Freddie's history as a portfolio lender, and is evidenced by Freddie's modest delinquency rates. Freddie Program Plus multifamily 60-day loan delinquencies have been only 1 to 5 basis points over the past three years, and have averaged only 12 basis points over the past ten years, even after a modest spike up in delinquencies during the recession.

Freddie had completed several securitizations from its multifamily portfolio by 2005, and the agency continues to issue occasional securitizations of seasoned and newly originated multifamily loans from its portfolio. To formalize multifamily securitizations, in 2006 Freddie established the K-Series securitization shelf, and by year end 2015 had issued $92.9 billion in guaranteed Freddie K-Series bonds. The Freddie K-Series program is unique in the ACMBS market, since it is similar to programs in the conventional CMBS market. Under the K-Series program, Freddie pools recently originated multifamily Program Plus loans from its portfolio and employs a credit structuring approach. Freddie and its underwriters sell subordinate bonds, which are credit-tranched as first loss through mezzanine bonds. Then Freddie and its underwriters sell the senior bonds, which carry a full guarantee by Freddie Mac. As a GSE, Freddie cannot carry an explicit US government guarantee, but investors in Freddie K-Series bonds have the Freddie Mac guarantee of timely payment of interest and ultimate payment of principal as well as the added credit support of the subordinate bonds.

Program Plus loans that are securitized in K-Series Freddie Mac transactions primarily have a 10-year balloon maturity with 9.5 years of yield maintenance, identical to most loans in FNMA DUS as well as conventional CMBS securities. Both FNMA and Freddie also issue 7-year balloons with 6.5 years of yield maintenance, and Freddie occasionally issues 5-year balloon maturities. The major difference in the agencies' programs is the bonds. FNMA DUS bonds are usually sold as one-off transactions, while Freddie Mac employs a conduit model, aggregating Program Plus loans and issuing large bond deals backed by numerous loans.

Through its underwriters, new Freddie K securitizations come to market monthly, and each transaction averages over $1 billion in size. In some months two new Freddie K securitizations come to market. Virtually every large Wall Street broker-dealer is involved underwriting Freddie K bonds, and the lead manager and co-manager positions rotate among the largest investment banks. Liquidity in Freddie Mac K bonds is supported by this consistent participation by Wall Street firms, as well as Freddie's consistency of issuance and the substantial outstanding float of Freddie K bonds.

Conservatorship of Freddie Mac and Fannie Mae

During the financial crisis of 2007–8, the substantial deterioration in the housing markets severely damaged the financial condition of Fannie Mae and Freddie Mac and left them unviable without government intervention. In response, Congress passed the Housing and Economic Recovery Act of 2008, created the Federal Housing Finance Agency (FHFA), and transferred supervision of Fannie Mae and Freddie Mac to FHFA. In September 2008, FHFA placed both agencies into conservatorship, which enabled the US Treasury to provide a total of $189.5 billion in financial support to the agencies to stabilize them and enable them to continue providing liquidity to the mortgage market. In turn, the Treasury took preferred stock in both FNMA and Freddie and required all agency profits to be remitted to the Treasury. In addition, FHFA required both FNMA and Freddie to shrink their balance sheets.

The Treasury has revised the terms of the 2008 preferred stock agreement with both agencies several times. By 2012 both Fannie Mae and Freddie Mac returned to profitability, and they continue to make progress reducing the size of their portfolios. By year-end 2014, the agencies had paid the Treasury $225 billion in dividends on the Treasury's $189.5 billion preferred stock. Both agencies remain in conservatorship under FHFA.

Key Points

- The ACMBS market consists of multifamily properties securitized and guaranteed by government agencies.
- Loans backing ACMBS bonds have call protection and short maturities and/or short refinancing periods.
- The call protection and short duration make ACMBS positively convex bonds, unlike single-family agency bonds.
- There are three primary securities programs that make up the ACMBS market.
- Ginnie Mae ACMBS have a US government full faith and credit guarantee and are commonly securitized in REMICS on Ginnie Mae's shelf.
- Fannie Mae ACMBS have a GSE guarantee, and trade as one-off bonds backed by one property, as pools of loans and in REMIC securitizations. Fannie Mae has the largest issued and outstanding float within the ACMBS market.

- Freddie Mac ACMBS have a GSE guarantee and are aggregated by the agency and securitized on Freddie Mac's "K" shelf. Freddie Mac K ACMBS are issued frequently and are large bond deals. Freddie Mac's K program resembles the conventional CMBS market more closely than other ACMBS programs.
- ACMBS are now underwritten and traded by every major Wall Street investment bank's mortgage trading operations.

CHAPTER 23

CMBS COLLATERAL PERFORMANCE

Measures and Valuations

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After reading this chapter you will understand:

- how CMBS loan collateral performance impacts the value of a CMBS bond in terms of the price yield and weighted-average life;
- why investing in CMBS bonds requires a careful review of the underlying loan collateral characteristics in order to formulate appropriate future default probability and loss severity assumptions;
- which factors are found to be most predictive of commercial mortgage loan credit performance;
- how the lending conditions prevailing at the time of underwriting influence the credit performance of a commercial mortgage loan or pool of commercial mortgage loans underlying a CMBS;
- the role of property type and loan factors in CMBS bond default and loss rates.

Investors purchase commercial mortgage-backed securities (CMBS) with the expectation of earning a desired internal rate of return from the receipt of coupon interest and return of principal. The return of principal may be realized by holding the bond to its scheduled maturity or by selling the bond at a market price prior to maturity. For the purpose of this chapter, our yield analytics will be from the "yield-to-maturity" perspective.

The conventional CMBS structure is a senior-subordinate, sequential-pay tranche structure backed by a pool of fixed-rate commercial mortgage loans. The underlying fixed-rate commercial mortgage loans typically have a 10-year term and 30-year amortization schedule. It is common for a certain portion of a CMBS pool to be comprised of loans that provide for "interest-only" payments during the loan term ("full IO" loan) or for the initial years of the loan term ("partial IO" loan) before converting to principal and interest payments. CMBS commercial mortgage loans require a balloon payment at maturity equal to the loans' unamortized loan balances. Fixed-rate CMBS commercial mortgage loans are structured with call protection and a hard maturity date. Call protection combined with a hard maturity date reduces the voluntary principal repayment variability to the CMBS bondholder. The variance between a CMBS bond's scheduled cash flows and actual cash flows is predominantly caused by the underlying pool's default- and loss-related cash flow variances.

The purpose of this chapter is to illustrate how CMBS loan collateral performance impacts the CMBS capital structure and the price–yield profile of individual CMBS bonds. First we review the CMBS capital structure. Then we review CMBS collateral default and loss history and describe those factors found to be most predictive of commercial mortgage loan credit performance. We conclude by examining how underlying collateral performance impacts the CMBS capital structure and the price–yield profile of individual CMBS bonds.

CMBS Capital Structure

Table 23.1 illustrates the conventional fixed-rate CMBS capital structure. The CMBS capital structure is described as a senior-subordinate, sequential-pay structure.

Table 23.1 An example of CMBS capital structure

JPMBB 2014-C24							
Class	Rating	Scheduled Balance	WAL	Spread	Price	Yield	Credit Support
A1	AAA	33,321,131	2.55	43	99.81	1.60	30.08
A2	AAA	184,014,000	4.30	48	103.12	2.16	30.08
A3	AAA	41,040,000	6.29	86	100.97	2.93	30.08
ASB	AAA	66,649,000	6.76	70	103.24	2.83	30.08
A4	AAA	265,000,000	9.17	84	101.30	3.22	30.08
A5	AAA	297,354,000	9.27	86	103.14	3.25	30.08
AS	AAA/AA+	76,279,000	9.33	115	102.99	3.54	24.06
B	AA–	76,278,000	9.33	145	102.20	3.84	18.05
C	A–	47,675,000	9.33	200	100.61	4.39	14.29
D	BBB–	81,046,000	9.33	370	85.17	6.09	7.90
E	BB	25,426,000	9.33	650	69.71	8.89	5.89
F	B	14,303,000	9.33	975	55.66	12.14	4.76
NR	NR	60,387,147	9.70	2,758	19.74	30.00	0.00
Trust Balance		1,268,772,278					

Source: Author constructed this table based on data from Intex Solutions.

Senior-Subordinate Structure

CMBS classes are arranged from top to bottom in order of repayment seniority. Remittance of the mortgage pool's interest and principal receipts is allocated from the top-down while default-related loan losses are allocated from the bottom-up. The "Rating" and "Credit Support" columns of Table 23.1 reflect this repayment seniority of the certificate classes. This example illustrates a conventional CMBS structure based on the JPMBB 2014-C24 transaction. Senior classes A1 through A5 benefit from 30% structural credit support and are rated AAA. As you move down the structure from Class AS through Class NR, the classes' relative seniority is reflected in the classes' declining level of credit support and lower rating. Class NR, for instance, is the most junior class in the structure. Class NR does not benefit from any structural credit support and is not rated. Class NR will experience a writedown to its certificate balance as soon as the underlying loan pool experiences its first principal loss. The most subordinate CMBS classes are priced with the expectation of some level of principal loss over the life of the mortgage pool and CMBS transaction.

Sequential-Pay Structure

Classes A1 through A5 are *pari-passu* with respect to principal loss exposure. However, these senior classes are time-tranched in order to create senior bonds with more narrowly defined cash flow profiles. The sequential-pay structure allocates principal received from the underlying mortgage pool to the then "front-pay" class at the top of the capital structure: Class A1 in the case of the JPMBB 2014-C24 transaction. Once Class A1 is reduced to a $0 balance, principal received from the underlying pool is allocated to Class A2 as the subsequent front-pay class. This sequence continues as principal is allocated to the then front-pay class. Only if the pool's cumulative losses eliminate credit support to the senior tranches will the multiple senior classes convert to a *pro rata* allocation of principal and losses.

Given the senior-subordinate and sequential-pay structure of the CMBS transaction, the CMBS investor considers classes that fit its credit risk tolerance and desired repayment and yield profile. To determine classes of interest, a CMBS investor makes assumptions with respect to the future credit performance of the collateral pool.

The CMBS investor must form an opinion as to the level and timing of collateral pool defaults and losses. Pool losses are realized when an underlying loan defaults and is subsequently liquidated through foreclosure, real-estate-owned (REO) sale, or other resolution strategy and liquidation proceeds are less than the total outstanding loan balance, including default interest and related fees and expenses.

CMBS Commercial Mortgage Default and Loss Rates

Since its inception in 1995, the CMBS market has produced over 700 fixed-rate CMBS transactions containing nearly 100,000 commercial mortgage loans. During this time, CMBS mortgage loan collateral has experienced several economic cycles and periods of accommodative capital markets as well as periods of restrictive capital markets.

For insight into CMBS commercial mortgage default and loss rates, we look at CMBS transaction-level loss experience from Bloomberg and Intex data and CMBS loan-level default and loss rates from CMBS research conducted by Wells Fargo Securities in their 2015 Default and Loss Study, completed in April 2015.

A review of transaction-level data and loan-level data reveals the following collateral performance statistics:

- For CMBS transactions issued from 1995 to 2013, the underlying loan cumulative default rate is 18% and the cumulative loss rate is 4.02%.
- For CMBS transactions seasoned at least ten years (1995–2004 vintages), the underlying loan cumulative default rate is 14.50% and the cumulative loss rate is 3.28%.
- Despite having less than ten years' default and loss history and a pipeline of yet-to-be resolved defaulted loans, transactions issued from 2005 through 2008 have an underlying loan cumulative default rate of 25% and cumulative loss rate of 5.46%.
- At the individual CMBS transaction level, cumulative losses average 4.27% of original pool balance for 1996 to 2008 vintage transactions, but loss levels vary widely from deal to deal. For 2005 to 2008 vintage transactions, cumulative losses average a higher 5.36%. The best-performing transactions experienced cumulative losses of less than 3.00% of original pool balance while the worst performing transactions have experienced cumulative losses to date in excess of 8% and reach as high as 16% of original pool balance.
- After taking into consideration yet-to-be-resolved defaulted loans, for the 2005 to 2008 vintage transactions, it is reasonable to expect cumulative losses to reach 6% to 8% on average and approach 20% of original pool balance for the worst performing transactions.
- For liquidated loans, the loss severity rate has averaged 39% of loan balance at time of liquidation. The 2004 CMBS cohort has the lowest overall loss severity rate at 31%. The 1995 and 2008 CMBS have the highest overall loss severity rates at 57% and 51% respectively.
- Annual defaults tend to peak between years four to six, following transaction issuance. Overall economic conditions and the real estate cycle can cause the default curve of a specific origination cohort to peak sooner or later than the long-term average.

Together, Tables 23.2 and 23.3 summarize the annual realized defaults and losses as well as cumulated defaults and losses by vintage cohort expressed as a percentage of original

Table 23.2 Timing of defaults by vintage

	Years from Issuance											
	1	2	3	4	5	6	7	8	9	10	11+	Cum. to Date
1995	0.00%	0.58%	1.99%	0.53%	1.90%	0.67%	4.44%	4.08%	0.41%	0.54%	0.43%	15.57%
1996	0.08%	1.06%	1.48%	0.82%	1.64%	3.09%	1.52%	1.61%	0.67%	0.52%	1.16%	13.65%
1997	0.16%	0.45%	1.03%	0.93%	2.39%	2.07%	2.67%	1.01%	1.34%	0.64%	1.56%	14.25%
1998	0.34%	0.53%	0.83%	1.20%	1.44%	1.45%	1.03%	0.88%	0.39%	2.18%	2.79%	13.06%
1999	0.08%	0.52%	0.91%	1.29%	1.86%	1.31%	0.89%	0.35%	0.39%	2.45%	4.06%	14.11%
2000	0.24%	1.10%	1.62%	1.89%	1.68%	0.87%	0.46%	0.72%	2.36%	5.95%	2.73%	19.62%
2001	0.34%	0.69%	1.08%	1.54%	0.95%	0.43%	0.77%	1.53%	3.02%	4.60%	2.13%	17.08%
2002	0.28%	0.38%	0.78%	0.39%	0.68%	0.55%	1.76%	2.29%	2.12%	3.02%	1.25%	13.50%
2003	0.08%	0.33%	0.31%	0.19%	0.52%	1.93%	2.32%	1.50%	0.84%	2.24%	0.73%	10.99%
2004	0.10%	0.26%	0.21%	0.57%	2.57%	4.07%	2.41%	1.52%	0.51%	2.48%	0.80%	15.50%
2005	0.15%	0.27%	0.37%	2.75%	5.96%	4.21%	2.20%	1.69%	1.14%	1.10%		19.84%
2006	0.15%	0.44%	3.34%	6.12%	4.64%	4.05%	2.13%	1.47%	0.78%			23.12%
2007	0.27%	3.06%	5.99%	7.46%	5.25%	5.12%	1.84%	1.18%				30.17%
2008	3.15%	6.90%	5.77%	1.88%	5.47%	2.13%	1.83%					27.13%
2010	0.00%	0.00%	0.00%	0.00%	0.12%							0.12%
2011	0.00%	0.06%	0.20%	0.11%								0.37%
2012	0.00%	0.19%	0.27%									0.46%
2013	0.13%	0.00%										0.13%

Source: Author constructed this table based on data from Intex Solutions and Wells Fargo Securities, LLC.

Table 23.3 Timing of losses by vintage

	Years from Issuance											
	1	2	3	4	5	6	7	8	9	10	11+	Cum.To Date
1995	0.00%	0.00%	0.00%	0.02%	0.07%	0.17%	0.10%	0.67%	0.91%	0.43%	0.14%	2.51%
1996	0.00%	0.01%	0.01%	0.02%	0.04%	0.19%	0.54%	0.60%	0.85%	0.48%	0.74%	3.48%
1997	0.00%	0.00%	0.01%	0.04%	0.23%	0.51%	0.46%	0.61%	0.50%	0.13%	0.46%	2.95%
1998	0.00%	0.01%	0.03%	0.12%	0.24%	0.45%	0.51%	0.19%	0.18%	0.10%	1.18%	3.01%
1999	0.00%	0.00%	0.02%	0.13%	0.29%	0.34%	0.26%	0.20%	0.17%	0.10%	1.63%	3.14%
2000	0.00%	0.01%	0.16%	0.31%	0.41%	0.32%	0.20%	0.14%	0.18%	0.56%	2.34%	4.63%
2001	0.01%	0.05%	0.06%	0.20%	0.28%	0.24%	0.13%	0.10%	0.58%	0.83%	1.90%	4.38%
2002	0.00%	0.02%	0.11%	0.10%	0.19%	0.04%	0.16%	0.43%	0.66%	0.62%	1.43%	3.76%
2003	0.00%	0.02%	0.01%	0.03%	0.04%	0.09%	0.31%	0.51%	0.40%	0.39%	0.70%	2.50%
2004	0.00%	0.00%	0.01%	0.07%	0.06%	0.31%	0.46%	0.56%	0.60%	0.51%	0.18%	2.76%
2005	0.00%	0.01%	0.01%	0.05%	0.39%	0.86%	0.74%	0.88%	0.77%	0.38%		4.09%
2006	0.00%	0.01%	0.03%	0.39%	0.94%	1.08%	1.49%	1.44%	0.41%			5.79%
2007	0.00%	0.01%	0.16%	0.83%	1.15%	0.91%	1.69%	1.00%				5.75%
2008	0.00%	0.14%	1.09%	1.43%	1.22%	2.14%	0.57%					6.59%
2010	0.00%	0.00%	0.00%	0.00%	0.00%							0.00%
2011	0.00%	0.00%	0.00%	0.00%								0.00%
2012	0.00%	0.00%	0.00%									0.00%
2013	0.00%	0.00%										0.00%

Source: Author constructed this table based on data from Intex Solutions and Wells Fargo Securities, LLC.

pool balance. The two tables illustrate the increased default and loss rates experienced in the 2005 to 2008 vintages.

Factors Influencing Default Rates and Loss Severity

Lending Conditions at Time of Loan Origination

The default and loss experience of CMBS commercial mortgages during the past 20 years suggests the lending conditions at the time of underwriting are perhaps the most important factor that influences the credit performance of a commercial mortgage loan or pool of commercial mortgage loans.

During "tight" lending conditions, commercial mortgage lenders and CMBS investors are selective in adding new credit risk exposure. Tight lending conditions may arise for a variety of reasons but typically are the result of tightening monetary conditions generally and/or the expectation that commercial real estate operating fundamentals are at risk. During "tight" lending conditions, lenders and CMBS investors are more conservative with respect to assumptions about the collateral property's anticipated occupancy, rental rates, net income, and ultimately valuation. Also during tight lending conditions, lenders and CMBS investors lend to more conservative standards of lower loan-to-values (LTVs) and higher debt service coverage ratios (DSCRs). Finally, during tight lending conditions, lenders and CMBS investors require more conservatively structured loan terms, including principal amortization during the full loan term and reserves established to mitigate potential term risks such as significant lease rollover during the term of the loan. During the past 20 years, notable periods of tight lending conditions included the years 2002 to 2003 and more recently 2009 to 2011.

During "easy" money conditions, commercial mortgage lenders and CMBS investors are motivated to add new credit exposure. Easy lending conditions typically arise when there is excess liquidity in the financial system and is usually but not necessarily accompanied by expectations of strengthening commercial real estate operating fundamentals. During easy lending conditions, lenders and CMBS investors are more optimistic with respect to assumptions about trends in property occupancy levels, rental rates, net income, and ultimately valuation. For example, during easy money conditions, a lender might view lease rollovers during the lease term as an opportunity to enter into new or renewal leases at increased rental rates rather than view lease rollovers as a risk of higher vacancy and lower property income. A recent notable period of easy lending conditions occurred from 2006 to 2008. For instance, the underwriting of "pro forma" income levels became increasingly common during this period. In short, pro forma income underwriting involved assuming property occupancy levels, rental rates, and net income levels that were higher than what was actually "in place" at the time of loan origination. To accommodate in-place property income that was less than the pro forma underwritten property income, pro forma underwritten loans were often structured with more generous full IO or partial IO loan amortization terms.

The purpose of this chapter is not to identify specific features of "conservatively" underwritten loans versus "aggressively" underwritten loans. We simply wish to point out here, that while there are a number of commonly identified loan and property collateral characteristics that influence commercial mortgage default and loss experience, it is the "lending conditions" and the underwriting and loan structuring practices arising therefrom that have an overarching influence on the credit performance of a commercial mortgage cohort.

The following sections discuss common property and loan factors that have been found to influence commercial mortgage default and loss rates.

Property Type

Property type is perhaps the single loan/collateral characteristic investors look at most to frame the credit risk of a mortgage pool or CMBS transaction. Historically, loans secured by hotels and healthcare properties have experienced high default rates and loss severities. This is due to the fact that these property types have a direct business operation component that drives property revenues, profitability, and value. Notably, fluctuations in the business component of non-core properties have a tendency to disproportionately affect property income and values. Additionally, non-core properties often require infusions of cash during workout to fund the business operation, which exacerbates the loss severity. For example, there have been cases involving both hotels and healthcare collateral where the addition of servicer advances during REO management and disposition has resulted in losses in excess of 100%.

Alternatively, core property types (office, retail, industrial, multifamily) have experienced lower default rates and less significant loss severities on average. The revenue, profitability, and value of the core property types are driven by diversified contractual lease income, which is less immediately and dramatically impacted by business fluctuations.

Table 23.4 compares loan performance by property type for the 1995 to 2013 CMBS vintages.

Location

The adage that the three most important ingredients to real estate are "location, location, location" applies to collateral performance. Location is an important determinant of the default probability and degree of loss severity upon default. Loans secured by

Table 23.4 CMBS performance by property type

Property Type	Cumulative Default Rate	Cumulative Loss Rate	Average Loss Severity
Multifamily	22%	4.05%	33%
Retail	15%	3.77%	45%
Office	19%	4.09%	37%
Industrial	19%	3.68%	37%
Hotel	22%	5.39%	42%
Healthcare	34%	8.39%	46%

Source: Author constructed this table based on data from Wells Fargo Securities, LLC.

properties in primary markets or major MSAs have experienced lower default rates and lower loss severities than loans secured by properties in secondary and tertiary markets. Primary markets tend to have more diverse economies and typically possess a broader real estate investor base which, combined, promote greater liquidity. Greater liquidity provides borrowers with better alternatives for funding and/or selling distressed commercial real estate. Greater liquidity typically translates into fewer price concessions for borrowers or special servicers attempting to sell a distressed real estate property.

Similarly, loans secured by properties possessing "barrier-to-entry" characteristics have experienced better credit performance than loans secured by properties with low barrier-to-entry characteristics. Properties with high barrier-to-entry characteristics are less vulnerable to sudden and excessive increases in competitive supply. A high barrier-to-entry characteristic might be a property's "in-fill" location where development opportunities are few and where land assemblage is prohibitively expensive.

Loan to Value and Debt Service Coverage Ratio

All other factors held constant, the incidence of default and loss rises with an increase in the underwritten loan-to-value ratio (LTV). Conversely, all other factors held constant, the incidence of default falls with an increase in the underwritten debt service coverage ratio (DSCR). However, it is necessary to consider the components of the underwritten LTV and DSCR. In particular, the CMBS investor must recognize the value component of LTV is based on assumptions made with respect to the collateral property's anticipated net income and the appropriate valuation (i.e. capitalization rate) of the anticipated net income. Likewise, several components to the DSCR dictate how the DSCR level should be interpreted. For instance, the debt service component of DSCR will vary depending on whether the loan is structured with principal amortization or, alternatively, is structured as a full IO loan. Loans structured with principal amortization during the loan term will have a larger periodic debt service payment obligation and consequently a lower DSCR than a similarly sized loan structured as a full IO loan. While a lower DSCR loan will have less net income cushion against a decline in property net income, principal amortization that has occurred prior to a default should be expected to reduce the loss severity in the event of default.

Amortization Schedule

As alluded to above, a shorter amortization schedule increases the probability of a term default on a loan because a shorter amortization schedule implies a higher debt service burden. However, as a loan ages, a shorter amortization schedule should result in a lower experienced loss severity in the event of default since the remaining loan balance will be lower than it otherwise would be with a longer amortization schedule. Also, at maturity, a loan with a shorter amortization schedule will have a lower maturity balloon balance which, all things being equal, will reduce the balloon maturity default rate and severity rate.

Coupon Spread

Historically, the difference between the loan rate and the average interest rate of a loan cohort has been a strong determinant of default. A loan cohort is defined in terms of origination month, property type, and loan size. Since the pricing of a loan reflects the perceived credit risk, coupon spread has historically been one of the best determinants of default probability and loss severity. Investors should note, however, the potential for a collateral property to be financed with multiple layers of senior and subordinate debt. This makes the coupon spread on the CMBS senior loan less predictive of default probability but perhaps more predictive of loss severity since any collateral value shortfall to the outstanding debt is borne first by the most junior debt positions. Conventional CMBS transactions are backed by pools of commercial mortgages that are in a first-lien security position.

Loan Size

Most mortgage loan research has shown that "large loans" have lower default probabilities than small loans. There are several reasons this could occur. Due to their size and potential impact on a CMBS pool, large loans are often underwritten more conservatively with lower LTVs and higher DSCRs. Also, large loans are typically made to strong borrower sponsors and secured either by a single high-quality dominant property or by a diversified portfolio of cross-collateralized properties. Both types of collateral tend to reduce the risk of default and loss, all other things equal. Finally, in the event of default and liquidation, disposition costs on large loans, while larger on an absolute basis, tend to be lower as a percent of outstanding loan balance than on small loans.

Loan Originator

The loan originator is a factor that can impact loan performance. The degree of due diligence a CMBS investor performs on originators is determined, largely, by where in the capital structure the CMBS investor participates and the degree of credit risk this implies. Among other things, a loan originator should be evaluated based on how and where the originator sources loans and competes to win business. Additionally, the investor should evaluate how the originator performs its due diligence and underwriting.

Age

For a given loan pool or cohort, the incident of default has been shown to increase during the first four to seven years after origination. Most default studies indicate that the default aging curve is steepest during the first 24–36 months and continues to increase until peaking in years 3–7. After peaking in years 3–7, the annual default rate declines as the loan pool ages. This is likely due to the build-up in borrower equity as a result of the amortization of the mortgage loan balance as well as an improvement in property value as rents and net operating income (NOI) improve during the loan term. Of course, the economic conditions and the real estate cycle can cause a particular cohort's default timing curve to peak sooner or later than the overall long-term average.

Default Rate, Loss Severity, and Valuation Issues

The price of a CMBS bond equals the present value of the bond's expected future cash flows discounted using the appropriate discount rate. Collateral performance has the potential to impact the realized yield on a CMBS bond purchase. The liquidation of defaulted loans often results in the prepayments of the most senior bonds within the CMBS trust. To the extent a loss is incurred on a liquidated loan, a proportionate write-down is made to the most junior bonds within the CMBS trust. Thus, the liquidation of defaulted loans has the potential to affect the weighted-average life (WAL) of the bonds and the credit enhancement in the CMBS capital structure.

In Table 23.5, we show a typical sequential-pay CMBS capital structure, and hypothetical pricing of the various classes. In a sequential-pay CMBS transaction, all the return of principal is paid to the front-pay class (in this case, Class A1) until the principal

Table 23.5 An example of CMBS tranches with indicative spreads and prices

JPMBB 2014-C24							
Class	Rating	Scheduled Balance	WAL	Spread	Price	Yield	Credit Support
A1	AAA	33,321,131	2.55	43	99.81	1.60	30.08
A2	AAA	184,014,000	4.30	48	103.12	2.16	30.08
A3	AAA	41,040,000	6.29	86	100.97	2.93	30.08
ASB	AAA	66,649,000	6.76	70	103.24	2.83	30.08
A4	AAA	265,000,000	9.17	84	101.30	3.22	30.08
A5	AAA	297,354,000	9.27	86	103.14	3.25	30.08
AS	AAA/AA+	76,279,000	9.33	115	102.99	3.54	24.06
B	AA–	76,278,000	9.33	145	102.20	3.84	18.05
C	A–	47,675,000	9.33	200	100.61	4.39	14.29
D	BBB–	81,046,000	9.33	370	85.17	6.09	7.90
E	BB	25,426,000	9.33	650	69.71	8.89	5.89
F	B	14,303,000	9.33	975	55.66	12.14	4.76
NR	NR	60,387,147	9.70	2,758	19.74	30.00	0.00
Trust Balance		1,268,772,278					

Source: Author constructed this table based on data from Intex Solutions.

on the class has been fully repaid. Once class A1 is repaid, class A2 becomes the front-pay class and receives all return of principal. During the life of a CMBS transaction, return of principal in any given month includes regularly scheduled return of principal through scheduled amortization and loan maturities. In addition, to the extent a defaulted loan is liquidated, available liquidation proceeds after deduction of accrued interest, advances, and liquidation expenses is used to pay down the front-pay class. If losses are incurred on the loan/collateral liquidation, these losses are allocated to the most junior "first-loss" class (in this case, Class NR). Losses are allocated to the first-loss class through the writedown of the principal of the class. If the first-loss class is fully written off, the next most junior class (in this case, Class F) becomes the first-loss class.

Using the same CMBS transaction, we show in Table 23.6 how loan default and losses impact the capital structure. In modeling loan default and losses, we assume a CDR default curve that generates 14.34% in cumulative defaults. Assuming a 35% severity rate would result in a cumulative loss of 5.01% of original pool balance. We note that in this example, the most senior bonds in the capital structure and the most junior bonds in the capital structure are most sensitive to this default scenario. The most senior bonds are impacted, primarily, by the shortening of their average life. The WAL of Class A1, for instance, shortens from 2.55 years to 2.39 years.

The most junior bonds, on the other hand, are impacted both by a change in their WAL and by an erosion of their credit support. The far right-hand columns of Table 23.6

Table 23.6 An example of CMBS tranche with default/loss WAL and credit support

		Original						Default-Adjusted					
Class	Rating	Scheduled Balance	WAL	Spread	Price	Yield	Credit Support	WAL	Spread	Price	Yield	Lowest Credit Support	% Class Writedown
A1	AAA	33,321,131	2.55	43	99.81	1.60	30.08	2.39	49	99.81	1.60	30.08	0%
A2	AAA	184,014,000	4.30	48	103.12	2.16	30.08	4.29	48	103.12	2.16	30.08	0%
A3	AAA	41,040,000	6.29	86	100.97	2.93	30.08	5.67	94	100.97	2.91	30.08	0%
ASB	AAA	66,649,000	6.76	70	103.24	2.83	30.08	6.76	70	103.24	2.83	30.08	0%
A4	AAA	265,000,000	9.17	84	101.30	3.22	30.08	8.57	88	101.30	3.21	30.08	0%
A5	AAA	297,354,000	9.27	86	103.14	3.25	30.08	9.27	86	103.14	3.25	30.08	0%
AS	AAA/AA+	76,279,000	9.33	115	102.99	3.54	24.06	9.33	115	102.99	3.54	24.06	0%
B	AA–	76,278,000	9.33	145	102.20	3.84	18.05	9.33	145	102.20	3.84	18.05	0%
C	A–	47,675,000	9.33	200	100.61	4.39	14.29	9.33	200	100.61	4.39	14.29	0%
D	BBB–	81,046,000	9.33	370	85.17	6.09	7.90	9.33	370	85.17	6.09	5.82	0%
E	BB	25,426,000	9.33	650	69.71	8.89	5.89	9.99	620	69.71	8.64	2.69	0%
F	B	14,303,000	9.33	975	55.66	12.14	4.76	10.47	685	55.66	9.33	0.00	22%
NR	NR	60,387,147	9.70	2,758	19.74	30.00	0.00	7.04	(280)	19.74	-0.63	0.00	100%
Trust Balance		1,268,772,278											

Source: Author constructed this table based on data from Intex Solutions.

indicate the lowest credit enhancement reached during the life of each class and the projected principal writedown to the class. In our example, class NR incurs a full principal writedown, and class F is projected to incur approximately 22% in principal writedown over time. While the mezzanine classes are not projected to incur principal writedown, classes D and E incur erosion in credit support which would place them at risk for rating downgrade, should projected losses materialize.

Despite experiencing a partial or full writedown of principal balance, it is possible for subordinate classes to generate an acceptable yield if the class is purchased at a sufficient discount and defaults and losses occur later in the terms of the underlying pool and certificate's life. In this respect, the subordinate bondholder benefits from earning a high coupon yield for many years prior to experiencing principal writedowns.

Key Points

- CMBS collateral performance impacts the CMBS capital structure and the price–yield profile of individual CMBS bonds.
- The liquidation of defaulted mortgage loans impacts the WAL of the CMBS trust's certificate classes as well as the credit support benefiting those classes.
- Evaluating a CMBS bond for investment purposes requires a review of the underlying loan collateral characteristics in order to formulate appropriate future default probability and loss severity assumptions for the underlying loan collateral.
- A number of property and loan characteristics suggest a higher or lower level of default and loss.
- In the analysis of CMBS, being cognizant of the lending conditions at the time of loan pool origination is perhaps the overarching factor that will drive a CMBS pool's default and loss performance.

PART VI

VALUATION AND PREPAYMENT MODELING

CHAPTER 24

VALUATION OF MORTGAGE-BACKED SECURITIES

RAJASHRI (PRIYA) JOSHI, TOM DAVIS, AND BILL MCCOY

After reading this chapter you will understand:

- the elements of MBS valuation, including the sources of prepayments and the models and assumptions that go into generating a speed forecast and a set of projected cash flows;
- definitions of the "static" valuation metrics and their limitations in the analysis of mortgage-backed securities;
- the main considerations in selecting a term structure model and an overview of Monte Carlo simulation for valuing MBS;
- definitions of the option-adjusted valuation metrics including OAS, effective duration and convexity, partial effective durations, and option cost;
- calculation and interpretation of the various valuation metrics via an illustrative example.

The valuation of mortgage-backed securities (MBS) is more complex than the valuation of noncallable corporate bonds and calls for a more sophisticated approach. The traditional static valuation metrics, such as yield, provide a starting point for MBS analysis, but have a number of limitations that restrict their utility. Option-adjusted valuation metrics provide a better gauge of MBS return but care must be taken in their interpretation. It is important to understand the strengths and weaknesses of the different valuation metrics, while keeping in mind that there is no single best measure of value. A variety of valuation metrics and analysis techniques, taken together as part of a consistent framework, help investors build an intuition of the drivers of return and associated risks of a target MBS.

This chapter describes and illustrates the elements and mechanics of valuing mortgage-backed securities. We begin with the basics of valuation and then briefly review the sources of MBS prepayments. Next, we discuss the models and assumptions that go into generating a set of projected cash flows. Given a cash flow forecast along a specified interest rate path, we can proceed on to valuation. We start with the traditional "static" valuation metrics and discuss their uses and limitations for MBS analysis. We then turn to the "dynamic" valuation approach that adjusts for the value of the embedded prepayment option. Finally, we provide a simplified example of MBS valuation that illustrates the key concepts discussed in this chapter.

Basics of Valuation

Any financial asset can be valued as the present value of its cash flows, calculated by discounting each cash flow using an appropriate rate based on the timing of the cash flow and the required rate of return, as shown in the following equation:

$$Value = \sum_{n=1}^{N} \frac{CF_n}{(1+r_n)^n} \tag{1}$$

where CF_n is the total cash flow in the nth period, r_n is the discount rate corresponding to a term of n periods, and N is the remaining term. A debt instrument with fixed cash flows, such as a noncallable corporate bond or Treasury, can be easily priced using equation (1). But the valuation of mortgage-backed securities is more complex because the periodic cash flows (i.e., the numerators in equation (1)), are nondeterministic. The cash flow uncertainty derives from the fact that in the United States, single-family home loans are usually freely prepayable by the mortgagor.[1] Each monthly cash flow consists of scheduled principal and interest as well as unscheduled principal payments, which are known as "prepayments." Prepayments constitute the dominant component of the total cash flow in MBS pools.

Prepayment rates or "speeds" can be measured in terms of a "single monthly mortality" (SMM) rate, which is the ratio of unscheduled principal to the "prepayable" balance. More precisely, the SMM in month n is given by the following:

$$SMM_n = 100 \times \frac{Tot\ Prin\ Pmt_n - Sched\ Prin\ Pmt_n}{Bal_{n-1} - Sched\ Prin\ Pmt_n} \tag{2}$$

where Bal_{n-1} is the actual balance at the *end* of month $n-1$ while $Tot\ Prin\ Pmt_n$ and $Sched\ Prin\ Pmt_n$ are the total and scheduled principal payments occurring *during* month n.

Prepayment speeds are usually reported as an annualized percentage rate called the *conditional prepayment rate* (CPR):

[1] The cost of the prepayment option is generally socialized in the United States, so all fixed-rate mortgagors pay for this privilege by paying a higher interest rate than if the mortgage were not prepayable; however, prepayment penalties sometimes apply to certain adjustable-rate mortgages (ARM) or hybrid ARM loans. In most other countries, prepayment penalties are much more broadly applicable, so only mortgagors who exercise the option are charged.

$$CPR = 100 \times \left(1 - \left(1 - \frac{SMM}{100}\right)^{12}\right) \tag{3}$$

Therefore, the first step in valuing a mortgage-backed security is to devise a methodology for projecting a sequence of monthly CPRs that can be used to compute the future cash flows of the MBS.

Sources of Prepayments in MBS Pools

Mortgagors prepay their loans for several reasons and the total SMM in any period is the sum of all of the types of prepayments that occur during the period.

Rate-Driven Refinancings

Rate-driven refinancings ("refis" hereafter) are the most volatile component of prepayments, with speeds surging when rates decline and falling sharply when rates increase. From this perspective, an MBS pool can be likened to a callable corporate bond. However, rate-driven refis are much harder to predict than corporate bond redemptions for several reasons:

- Mortgage-backed securities have embedded within them hundreds or thousands of individual prepayment options—the investor has in effect sold a call option to each underlying mortgagor. So it is necessary to project the collective responsiveness of a large number of mortgagors versus a single entity (typically the chief financial officer of the issuing corporation).
- The economics of refinancing differs across mortgagors because of factors such as variation in the note rate, expected home tenure, and credit profile.
- Redemption efficiency also varies across mortgagors as the most financially savvy mortgagors tend to refinance relatively promptly, while less savvy or more credit-impaired mortgagors are more likely to delay exercise.

Collectively, these differences versus callable corporates introduce an additional random element into MBS cash flows. This increases the uncertainty inherent in the timing of return of principal and in the total interest paid over the life of a pool.

Housing Turnover

Housing turnover (turnover hereafter) is the second most significant source of prepayments in agency MBS pools and generally becomes the dominant component of total speeds when a pool is out of the money. Conventional mortgage loans typically contain a "due on sale" clause, so a property sale leads to a prepayment of the outstanding loan balance.[2] Turnover speeds tend to be very slow early in the life of a mortgage pool, especially in the case of purchase loans, as mortgagors who have recently moved are unlikely to do so again for a while. Turnover speeds typically rise to their fully seasoned level over the course of two to three years.

Turnover does show some dependence on interest rates—mortgage rates influence affordability, so higher rates can make it harder for mortgagors to trade up. Furthermore, a mortgagor with a below-market note rate may be reluctant to relinquish that rate and may delay moving. This phenomenon is known as "lock-in." However, home sales are much less dependent on interest rates than refinancings because home sales are often motivated by necessity (e.g., marriage, divorce, growing family, and job change), placing a floor on turnover speeds as well as total prepayment speeds.

Less Significant Sources of Voluntary Prepayments

Mortgagors who have accumulated significant equity since loan origination (via amortization or an increase in home value) may refinance the existing loan to extract some of that equity. This is known as a *cashout refinance*. The mortgagor may be facing financial hardship or may wish to use the cash for home improvements or to pay down non-tax-deductible consumer debt. Cashouts are primarily motivated by a desire for cash. So, under certain circumstances, a mortgagor may choose to extract equity even if it results in a slightly higher mortgage rate.

Mortgagors whose credit profile has improved considerably since loan origination may be able to qualify for cheaper financing, even if overall interest rates have not declined. This is known as a *credit-driven refinance*. In theory, credit-driven refi rates should be negligible for several months after loan origination and tend to gradually rise as the pool seasons and the underlying mortgagors continue to make on-time payments on their mortgages and other financial obligations.

Debt aversion or the desire to build equity faster may lead some mortgagors to accelerate loan paydown by remitting more than the scheduled monthly payment. This is known as a *curtailment* and is passed through to investors as a partial prepayment of the outstanding balance. Curtailments, as well as full payoffs, tend to increase late in the life of a pool as mortgagors grow older and wish to eliminate mortgage debt prior to retirement. Older mortgagors may also be more financially stable than their younger counterparts, and are more likely to have spare cash available that can be used to reduce mortgage debt.

Involuntary Prepayments

When a mortgagor stops making timely mortgage payments, the owner of the mortgage note has the right to foreclose on the property, leading to a prepayment, principal write-

[2] FHA and VA loans are assumable, so a property sale may not lead to a prepayment.

down, or some combination of the two. Regardless of whether the defaulted loan backs an agency or non-agency pool, it flows through the same process of moving from foreclosure to real-estate-owned (REO) or other form of liquidation. But there is a difference in how losses are recognized on defaulted loans within agency versus non-agency mortgage pools. In agency pools, a loan default is passed through to investors as a full prepayment of the principal balance; in non-agency pools, a default may be recognized as a partial or full writedown of the outstanding loan balance if the net sales proceeds are insufficient to pay off the loan.

Current loan-to-value (LTV) ratio is the key determinant of default. In theory, default should not occur so long as the current LTV is under 100%, because the mortgagor can simply sell the property to avoid default. *Strategic defaults*, which are driven solely by current LTV, were once relatively uncommon, but have become more prevalent since the financial crisis of 2008. A strategic default differs from a regular default in that the mortgagor may be able to make the monthly mortgage payments but has chosen not to do so. However financial hardship also plays a role in regular mortgage defaults. As such, the mortgagor's credit profile and external macro factors are important default drivers.

Elements of MBS Valuation

The computed price of an MBS is a function of the models, market views, and numerous assumptions that go into projecting its cash flows. Forecasting MBS prepayment speeds and, in turn, total cash flows, is a more complex undertaking than predicting the timing of redemption of a callable corporate bond. Total speeds are a function not just of interest rates, but of a wide range of factors including home price appreciation, housing affordability, demographic trends, consumer sentiment, wage growth, availability of mortgage credit, lending standards, and tax policy, to name a few.

Practitioners generally rely on econometric prepayment models, and associated auxiliary models, to generate speed and cash flow forecasts. These models project speeds based on a selected set of explanatory variables and make many assumptions on the future evolution of the drivers of prepayments along with the interrelationships between the various sources of prepayments. It should therefore be clear that any set of prepayment projections and associated valuation metrics contains a subjective element. In short, MBS prepayment modeling and valuation is part science, part art. We review the main elements and assumptions of MBS valuation in the following sections.

Modeling Mortgage Prepayments in an Evolving Market

The heart of any prepayment model is the *S-curve* (see Figure 24.1) which graphically represents the relationship between total prepayment speeds and the interest rate incentive to refinance. The figure illustrates the lower redemption efficiency of the prepayment

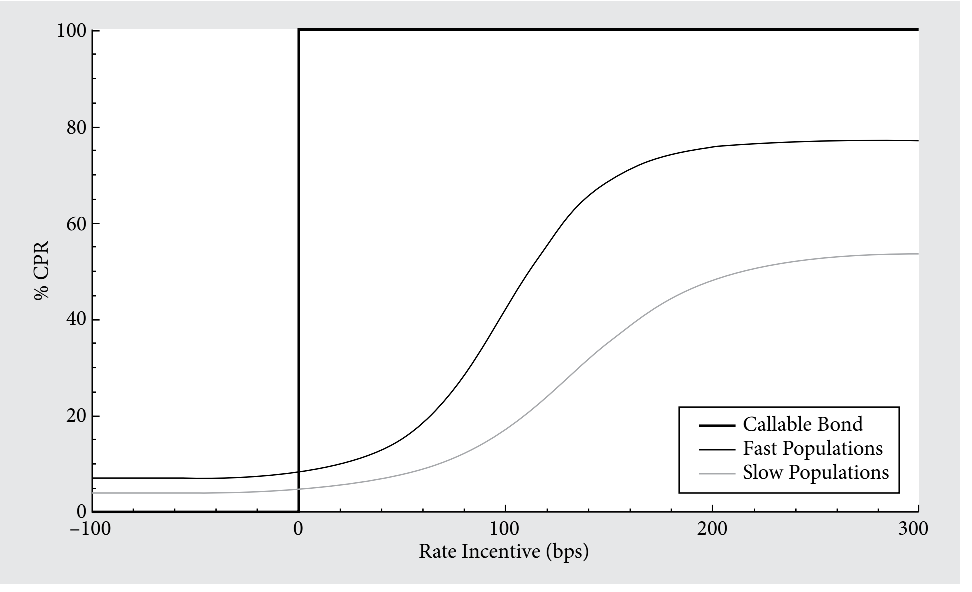

FIGURE 24.1 The heart of any prepayment model is the S-curve

option versus that of a callable corporate bond. The interest rate sensitivity of a callable corporate ideally takes the shape of a step function, a limiting case of an S-curve, meaning that the full outstanding balance is redeemed at par the first time the option is in the money. The figure also shows that total MBS speeds fall sharply when rate incentive decreases, but do not decline to zero, primarily because of the floor implied by housing turnover. Finally, the figure illustrates the variation in reactivity across the "fast" and "slow" subpopulations within a pool.

A pool's aggregate S-curve is not static—it represents the rate sensitivity of prepayment speeds at a particular point in time, based on the composition of the pool at that time and prevailing market conditions. The shape of the S-curve (slope, amplitude, and elbow) gradually changes over time as the pool composition evolves, in part because of the difference in realized speeds across the fast and slow populations within the pool. The economic environment, underwriting standards, and policy initiatives also drive the overall shape of the S-curve. *Seasoning* also plays a role—pools backed by newly originated loans tend to be less responsive to interest rates, as mortgagors who have just refinanced or recently purchased a home are less likely to immediately move or refinance again, regardless of rate levels. Reactivity gradually increases, or equivalently the S-curve becomes steeper, as the pool seasons. But responsiveness tends to be lower on very seasoned pools, as the most reactive mortgagors have already exited the pool. The changing responsiveness to interest rates leads to path dependence, which in turn dictates the appropriate valuation methodology for mortgage-backed securities, as we will see later in this chapter.

Regression analysis provides a useful starting point in identifying the key drivers of prepayments for various collateral types. It is important to choose a long historical calibration period so as to span a variety of economic backdrops and market environments. However, a modeling approach that relies too heavily on the historical experience may not respond appropriately to changing market conditions. The post-market-crash performance of mortgage default models illustrates this point. Because of the limited availability of historical mortgage default data prior to the 2008 financial crisis, most models failed to predict the subsequent surge in default rates and severities; conversely, post-crisis models may have swung too far in the other direction. Given the large number of factors that influence MBS prepayment rates, a purely statistical approach is unlikely to result in a stable, defensible, and intuitively satisfying model, and as a result, rational valuations. As such, the modeler's forward-looking judgment on mortgagors' motivations and behavior plays as much of a role in projecting MBS cash flows as the results of statistical analysis.

Projecting a Primary Mortgage Rate Path

Any forecast of MBS prepayments and cash flows is contingent on a specified path of primary mortgage rates. The primary rate on a 30-year fixed-rate mortgage is generally highly correlated with 10-year Treasury or 10-year swap yields. But it is also influenced by factors that are not directly observable in the market, such as origination capacity, relative demand for MBS versus Treasuries, and credit overlays that lenders may be applying. Regulatory initiatives, such as the Fed's large-scale asset purchase programs and Basel III bank capital adequacy standards, also play a role in determining the primary mortgage rate. In addition, mortgagors have a choice of many products when refinancing into a new loan. So, a mortgage valuation model that covers the full range of pool types requires projections of a range of primary mortgage rates, including 30-, 20-, 15-, and 10-year fixed mortgage rates, 3/1, 5/1, 7/1, and 10/1 hybrid ARM mortgage rates, FHA and VA mortgage rates, and jumbo mortgage rates.

Housing Market Outlook

Mortgage valuation also requires practitioners to take a view on housing market fundamentals. More specifically, an MBS cash flow forecast is contingent on an assumed path of home price appreciation (HPA), the pace of future home sales, the availability of mortgage credit, and other housing-related drivers. Cumulative HPA is a key determinant of current LTV, which is the main driver of mortgage defaults. HPA is also a determinant of loss severity and the recovery lag on non-agency loans. Likewise, the frequency of cashout refis is also directly tied to HPA, as it determines the pace at which borrowers build extractable equity.

Housing fundamentals also drive turnover speeds. Turnover can be estimated as the ratio of existing home sales to the total single-family housing stock. The correlation between the two metrics is not perfect, as the existing home sales/housing stock ratio is based on the entire housing market, consisting of properties backing agency loans, non-agency loans, and whole loans, as well as foreclosed properties and homes without a mortgage. However, this ratio still provides a good sense of aggregate turnover trends. Moreover, HPA encourages trade-ups, leading to a shorter turnover seasoning ramp and faster aggregate speeds. Strong home price growth can also encourage lenders to loosen underwriting standards, which can help to support home sales, especially for first-time buyers.

What Does the Model Leave Out?

Practitioners should take time to fully understand the model assumptions and the implications on valuations. A practitioner should also be aware of the scope of the model in use, recent market changes that the model may not be capturing, and any other limitations. The practitioner should ask questions such as the following:

- Are there important prepayment drivers that the model excludes?
- Is the model capturing the impact of recent regulatory initiatives?
- Is the projected primary mortgage rate path reasonable?
- Is the model assumption on home price growth realistic?
- Are aggregate turnover speeds appropriate, given the economic environment and housing fundamentals?

Most prepayment models expose certain dials that the practitioner can adjust in order to express a difference of opinion versus the model assumptions, or to extend the model to handle out-of-scope collateral types. Common user-facing dials include refi and turnover multipliers, refi S-curve steepness and elbow shift, length of the turnover seasoning ramp, and overrides on external economic drivers such as HPA.

Static Valuation Metrics

Armed with the projected cash flows on an MBS generated by a prepayment model along a specified interest rate path, we can calculate a variety of static valuation metrics that are traditionally used in bond analysis.[3]

Given an appropriate discount rate, equation (1) can be used to compute the price of an MBS. Alternatively, the same equation can be used to back out a *yield to maturity* given the market price of the bond. The yield to maturity is the value of y_{MBS} that solves the following equation:

[3] To price structured mortgage-backed securities, such as agency collateralized mortgage obligations (CMOs) or non-agency REMIC classes, it is also necessary to model the cash flow waterfall (i.e., the collection of rules for distributing principal and interest payments from the underlying mortgage pool to the various tranches, as specified in the deal documents).

$$Market\ \ Price = \sum_{n=1}^{N} \frac{CF_n}{(1+y_{MBS})^n} \tag{4}$$

Because an MBS returns principal to investors throughout the life of the pool, it is useful to calculate the average time to receipt of principal, known as the *weighted-average life* (WAL), as shown below:

$$WAL = \frac{1}{12} \frac{\sum_{n=1}^{N} n \times P_n}{\sum_{n=1}^{N} P_n} \tag{5}$$

where P_n is the principal received in month *n*. WAL differs from duration (discussed later) in that WAL is based on principal payments only, while duration is computed based on total cash flows. Furthermore, WAL does not involve discounting, in contrast to duration which is based on present values.

It is also useful to estimate the incremental return that mortgage-backed securities offer over a selected benchmark in order to gauge relative value. The simplest measure of incremental return is *nominal spread*, which is simply the excess yield on an MBS over a specified point on the benchmark yield curve. Nominal spread is usually measured with respect to the interpolated Treasury or swap whose WAL matches the WAL of the MBS. In the case of non-amortizing securities like Treasuries or "bullet" corporates, the entire principal balance is returned at maturity, so the remaining term is identical to WAL.

$$Nominal\ \ Spread = y_{MBS} - y_{Matching\ \ WAL\ \ Benchmark} \tag{6}$$

A limitation of nominal spread is that it is computed with reference to a single point on the benchmark yield curve and therefore does not take into account the fact that MBS principal is returned to investors throughout the life of the pool. A better measure of incremental return versus a benchmark is the *z-spread*, which is the value that solves the following equation:

$$Market\ \ Price = \sum_{n=1}^{N} \frac{CF_n}{(1+y_n + Z\text{-}Spread)^n} \tag{7}$$

where y_n is the interpolated Treasury or swap yield corresponding to a tenor of *n* months. The z-spread may be computed off of the spot yield curve, as shown above, or off of the forward curve, as shown below:

$$Market\ \ Price = \sum_{n=1}^{N} \frac{CF_n}{\Pi_{m=1}^{n}(1+f_m + Z\text{-}Spread)} \tag{8}$$

where f_m is the one-month forward rate for month *m*. The z-spread is sometimes referred to as the "zero vol, OAS" for reasons that will become clear later in this chapter.

If the reference yield curve is relatively flat, the z-spread is generally close to the nominal spread.

Limitations of the Static Metrics for Valuing MBS

The traditional static valuation metrics provide a starting point for MBS analysis, but have a number of limitations that restrict their utility. Perhaps the most obvious limitation of the static approach is that the prepayment projections, cash flows, and associated valuation metrics are contingent on the single assumed primary mortgage rate path being realized. Any deviation of realized primary mortgage rates from this projected path can dramatically alter the MBS cash flows and any assessments of relative value.

Another drawback of the static approach is that the static yield may significantly overstate the return that the investor will actually earn. Recall that yield equals the return only if the bond is held to maturity and the reinvestment rate on all intermediate cash flows equals the yield itself, which is extremely unlikely to occur for any fixed-income investment. However, in the case of an MBS, this shortcoming of yield is amplified by the impact of the embedded prepayment option. When rates rally, prepayment rates increase, and more principal is returned to the investor, which must be reinvested at a lower rate, resulting in a significantly lower return than implied by the static yield. Conversely, when rates rise, prepayment rates decrease, and less principal is returned to the investor, which cannot be reinvested at a higher rate, again resulting in a significantly lower return than implied by the static yield.

An MBS usually offers a higher static yield than duration-matched Treasury securities or swaps. This makes sense, because an unhedged MBS investor is taking a view not only on interest rate levels, but also on interest rate volatility. If rates do not move much over the holding period, an MBS position that is duration-hedged with an appropriately sized short position in Treasuries or swaps should provide a positive return, as predicted by the nominal yield spread. But if rates move significantly and prepayments vary, an MBS will likely underperform the duration hedge. Static yield fails to alert the investor to this dynamic behavior.

Yet another limitation of the static valuation approach is that the traditional closed-form duration measures, such as modified duration, cannot be used to accurately gauge the sensitivity of MBS prices to interest rates. To see this, recall how modified duration is computed for a bond with fixed cash flows. We start by differentiating the bond price with respect to yield, as follows:

$$\frac{dP}{dy} = \frac{d}{dy}\sum_{n=1}^{N}\frac{CF_n}{(1+y)^n} = -\sum_{n=1}^{N}\frac{n \times CF_n}{(1+y)^{n+1}} \tag{9}$$

Duration is expressed as a percentage of the bond price:

$$Modified\ Duration = -\frac{1}{P}\frac{dP}{dy} = \frac{\sum_{n=1}^{N} \frac{n \times CF_n}{(1+y)^{n+1}}}{\sum_{n=1}^{N} \frac{CF_n}{(1+y)^n}} = \frac{\frac{1}{(1+y)}\sum_{n=1}^{N} n \times PV(CF_n)}{\sum_{n=1}^{N} PV(CF_n)} \tag{10}$$

But if we attempt to apply the above methodology to an MBS, we encounter a problem. This simple method for calculating duration is unable to account for the change in cash flows and resulting "price compression" that occurs when yields fall. As discussed above, when rates rally, prepayment speeds increase, leading to a lower price than on an otherwise identical option-free bond. Figure 24.2 shows the relationship between price and yield for a hypothetical MBS, illustrating the price compression and negative convexity that are inherent features of all callable bonds.

To be sure, the static valuation metrics are more meaningful for gauging the value of certain types of mortgage-backed securities with limited prepayment risk. For example, call-protected CMOs such as planned amortization classes (PAC) typically price to a static yield or spread; likewise, MBS pools backed by ARMs are typically quoted in terms of z-spread. But the static metrics are of limited use in valuing most other types of MBS, including fixed-rate mortgage passthroughs, interest-rate-sensitive CMO classes such as support tranches, and mortgage derivatives (such as IO and PO classes, floaters, and

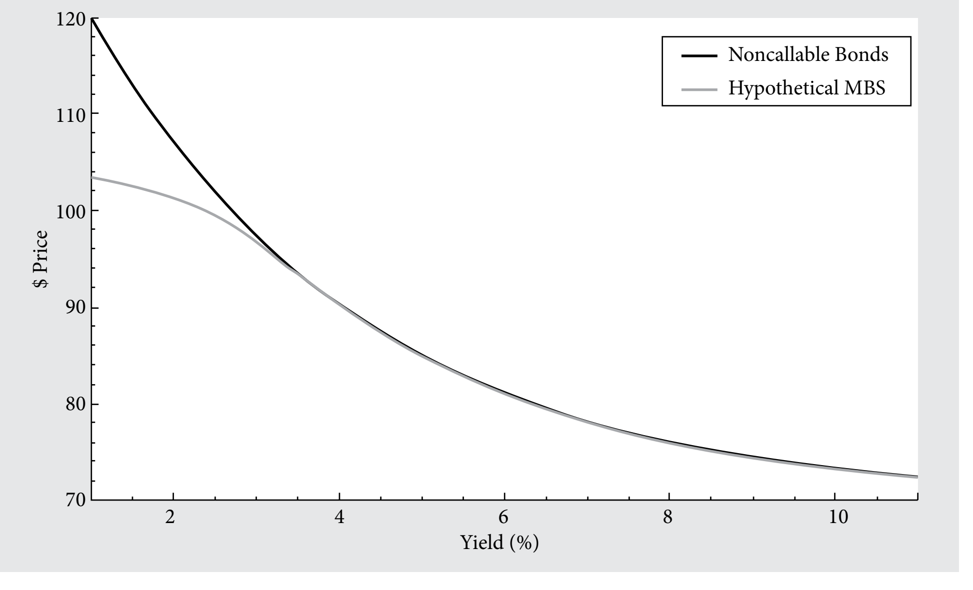

FIGURE 24.2 The price–yield relationship for a mortgage-backed security illustrates price compression

inverse floaters). Indeed, the static metrics are likely to lead to unreliable assessments of relative value across much of the MBS universe.

Approaches to Valuing the Embedded Prepayment Option

MBS valuation calls for a methodology that accounts for the impact of interest rate volatility and fully adjusts for the value of the embedded prepayment option. So, how can we go about valuing the option? A closed-form solution, when available, is ideal. But closed-form valuation formulas, like that provided by the Black–Scholes option pricing model, exist only for the simplest types of options, such as plain vanilla European-style options on stocks or swap rates. These closed-form formulas are certainly not available for valuing options as complex as the prepayment option that is embedded within mortgage-backed securities.

Implications of Path Dependence

An alternative methodology for valuing a callable bond is to use a lattice-based approach, such as backward induction on a calibrated trinomial tree. This approach works well for many types of callable corporates. But mortgage-backed securities cannot be priced on a recombining tree because of the path-dependent nature of the embedded prepayment option. *Path dependence* means that the future cash flows at any point in time are a function not just of prevailing interest rate levels, but also of the path along which interest rates (and other driving variables) reached their current level.[4] Path dependence implies that there is not a single price at any given node of the lattice, but rather multiple prices, depending on the path along which that node was reached.

Burnout is a well-known example of how path dependence manifests itself in MBS prepayment behavior. The responsiveness of a mortgage pool at any point in time is a function of the degree of past exposure to refi opportunities. When a pool moves into the money, the most reactive borrowers refinance and exit the pool, leaving behind the less reactive borrowers. Therefore, all else equal, a pool that has been deep in the money for an extended period in the past is likely to be much less reactive than an otherwise similar pool that moves into the money for the first time since origination. The interaction between involuntary and voluntary prepayment speeds is another illustration of path dependence—fast early prepayments in a mortgage pool are likely to reduce lifetime cumulative defaults, since fewer loans remain outstanding that can default in the future. Moreover, the passage of time itself can lead to changes in the responsiveness of a pool, as the profile of the underlying mortgagors changes.

[4] Technically this means that the price of an MBS does not follow a Markov process, a fact that precludes the use of lattice-based approaches.

As such, to correctly price an MBS and fully account for the embedded prepayment option, we must look beyond closed-form solutions and the lattice-based methods that are used in the valuation of less complex financial instruments.

Using Monte Carlo Models for Valuing Path-Dependent Instruments

Monte Carlo simulation is the preferred method for pricing mortgage-backed securities. Monte Carlo is a statistical method wherein the set of financial observables required for pricing a security are simulated a large number of times—each simulation is known as a "path." The security cash flows are then determined on each path and the price of the security is determined as the average of the discounted cash flows over all of the paths.

Broadly speaking, there are four steps in the Monte Carlo process. First, a model of the evolution of interest rates must be selected. The choice of model is determined by characteristics of the security—a balance must be struck between sufficient realism to capture the dynamics that drive the variability in the security price and computational complexity. Second, the model must be calibrated, which amounts to tuning the model parameters based on some predetermined criteria. At this point, if the model is too computationally expensive, factor reduction must be employed. Therefore, the third step is factor reduction, which is a method of reducing the model complexity such that the price of the security can be determined in a reasonable amount of time with limited resources. The final step is to generate the paths by using the calibrated model to evolve the financial observables. The security can then be priced as the average of the discounted cash flows along these paths.

We briefly describe each of these steps in the next sections. Our goal here is not to provide a full exposition on term structure modeling and Monte Carlo methods, but rather to give an overview of the various types of term structure models, the considerations that go into selecting a model, and the elements of the Monte Carlo option pricing framework.[5]

Choosing an Interest Rate Model

The first step in the Monte Carlo process is selecting an appropriate interest rate model. The 10-year swap rate is closely correlated with the primary mortgage rate which is a key driver of MBS cash flow and valuation dynamics. The swap rate is a weighted average of observable

[5] For more information on this rich topic, see Damiano Brigo and Fabio Mercurio, *Interest Rate Models: Theory and Practice* (Heidelberg: Springer, 2006); Paul Glasserman, *Monte Carlo Methods in Financial Engineering* (New York: Springer, 2003); and Alan Brace, *Engineering BGM* (Boca Raton: Chapman & Hall, 2008)

forward rates where the weightings are determined by the prices of zero-coupon bonds throughout the entire 10-year tenor of the swap. As forward LIBOR rates rise, the forward swap rate correspondingly rises. However, as the shape of the yield curve changes to inverted or to hump-shaped, the swap rate changes become harder to predict. Therefore, it is clear that any model of the evolution of expected LIBOR rates must contain sufficient structure to model the covariances that exist between the LIBOR rates in a realistic way.

Modeling the future values of interest rates can be done in a number of ways. There exist econometric models, most notably the Nelson–Siegel parameterization, which uses economic motivation to parameterize the yield curve. The parameters are determined for a series of dates in the past, and future interest rates are predicted by using the historical covariances of the parameters. This type of evolution is known as the "real-world measure" method and is widely used in risk modeling where the future evolution of the yield curve must closely reflect the past evolution. However, a drawback of this method is that it does not fit today's term structure exactly and therefore would not correctly price hedging instruments.

The preferred alternative is to use an arbitrage-free model of the term structure. When the model is arbitrage-free and calibrated to market prices, the consistent application of the model to both the MBS and the hedging instrument eliminates the potential for pricing biases, improving the quality of the hedge. Arbitrage freedom is guaranteed by the Heath–Jarrow–Morton (HJM) condition, which is a relationship between the drift over time and volatility of the evolution of the forward curve. There are two general classes of HJM models—continuous-rate models and market models.

In the case of continuous-rate models, the yield curve is represented by the instantaneous forward rate, i.e., the rate at a specific time for lending over an infinitesimally short time horizon. The most well known of the continuous-rate models are the short-rate models such as Ho–Lee, Black–Karasinski, Vasicek, and Hull–White. In these models, the instantaneous short rate is modeled, and this one factor drives the dynamics of the entire forward rate curve. It is clear that any one-factor model will not perform adequately for applications to MBS, since a single factor cannot capture the dynamics of the slope of the yield curve and will thus produce too large a correlation between forward LIBOR rates. There also exist multi-factor extensions to these single-factor models that give a richer structure of the correlation and covariance of the observable forward rates and corresponding swap rates. However, a drawback of all continuous-rate models is that the short rate is not a true financial observable since there is no market security that transacts which depends on this hypothetical rate.

In the case of market models, the underlying factors are the observable rates themselves. The most popular model in this class is the LIBOR market model (LMM),[6] where the set of forward LIBOR rates spanning a time horizon are the underlying stochastic factors.

Table 24.1 summarizes the benefits and drawbacks of several popular interest rate models. The continuous-rate models have the benefit of simplicity and, in some cases,

[6] The LIBOR market model is also known as the BGM model, so named for its developers Brace, Gatarek, and Musiela.

Table 24.1 Benefits and drawbacks of popular interest rate models

Model	Benefits	Drawbacks
Ho–Lee	Closed-form solutions for bond options, caps/floors, swaptions.	Unrealistic modeling of the interest rate, no mean reversion.
Hull–White	Closed-form solutions for bond options, caps/floors, swaptions. Mean reversion, implying a humped structure for the volatility term structure, something usually seen in market data.	Single-factor models lead to a much higher forward rate correlation than is seen in the market.
Black–Karasinski	Lognormal rates, meaning rates cannot go negative. Until recently, the non-negative rates assumption was heralded as a benefit of interest rate models. However, in 2015, many non-US rates went negative.	Leads to nonsensical results for Eurodollar futures, due to the model's assumption of lognormality of rates.
LIBOR Market Model	Driving factors are financial observables. Approximate closed form for swaptions.	High dimensionality of the model can lead to large computational runtime.

admit closed-form solutions for the prices of certain types of securities. The fact that there are closed-form solutions can greatly enhance the accuracy (as well as the speed) of the Monte Carlo simulations.

The preferred model for MBS pricing is the LMM, since it has a large number of underlying factors and the ability to reproduce complex interest rate dynamics. A drawback of the LMM is that the potential number of underlying factors, given by the number of LIBOR periods in the time horizon of interest, can become overwhelming. For example, if 1-month LIBOR is being simulated for 30 years, the number of stochastic factors is 360 (= 30×12). Therefore, after calibration is performed, a factor reduction process is usually necessary.

Calibrating the Model

To use the LIBOR market model to evolve the yield curve, the model must first be calibrated. For the LMM, the required parameters are the initial term structure of interest rates, the volatilities of the individual LIBOR rates, and the correlations across LIBOR rates. The volatility and correlation parameters are grouped into a covariance matrix. There are two approaches to determining the parameters of the model.

One approach to determining the model parameters is to derive a covariance matrix based exclusively on historical data. However, historical time series analysis typically produces covariance matrices that render the model internally inconsistent. Furthermore, an approach that relies exclusively on the historical data leads to a model that is not guaranteed to reflect the information on the future evolution of interest rates that is implied by the current, forward-looking prices of securities.

The preferred approach to determining the model parameters is to calibrate the covariance and correlation to the current prices of market instruments. Market-implied calibration begins with the current prices of traded securities and the initial term structure of interest rates: short-term cash instruments, forward rate agreements, swaps, caps/floors, and swaptions. As with all HJM models, the initial term structure of interest rates is an input and therefore the prices of zero coupon bonds are guaranteed to be exactly reproduced on average by the Monte Carlo simulation. Collectively, caps and floors contain the information about the volatility of the set of forward rates, while swaptions are used to extract the correlations between the forward rates. The output of the calibration process is the covariance matrix that is implied by the market prices of currently traded securities. The entire calibration process is verified by ensuring that the model closely reproduces the current market prices of bonds, caps, floors, and swaptions.[7]

Factor Reduction

The third step in Monte Carlo process is to reduce the number of model factors that need to be simulated. LIBOR market models can have hundreds of underlying factors. By choosing even a modest number of Monte Carlo paths, this explosion of dimension could create a need to generate millions of correlated random numbers, which is untenable in terms of computational time as well as storage requirements. Factor reduction techniques help to mitigate this issue.

The goal of the factor reduction is to reduce the number of stochastic factors of the model, but in a way that preserves the calibrated covariance structure as much as possible. The first step is to perform a principal component analysis (PCA) on the previously calibrated covariance matrix. PCA is a mathematical procedure that rearranges the covariance matrix in order of the most important contributors to the overall variance. The result of the PCA is a new set of factors called "principal components" that are linear combinations of the original factors that preserve the calibrated covariance structure. The principal components can be ranked in terms of the amount of covariance that they contribute to the overall covariance matrix. Thus, instead of simulating each individual LIBOR, the largest principal components are simulated.

The first three principal components of interest rate movements are directly related to three well-known movements of the yield curve: parallel shift, twist, and buckle. These three principal components will generally explain a large share of the covariance of the yield curve. Since the amount of covariance explained by the principal components can be quantified, it can be used as the decision criterion to determine how many principal components to use in the Monte Carlo simulation. Usually the first three principal components suffice, as they typically account for over 70% of the total covariance.

[7] There exist some parametric forms of the volatility term structure where the prices of market securities cannot all be exactly matched. In this case, the best fit is produced by minimizing the error between the market and model prices.

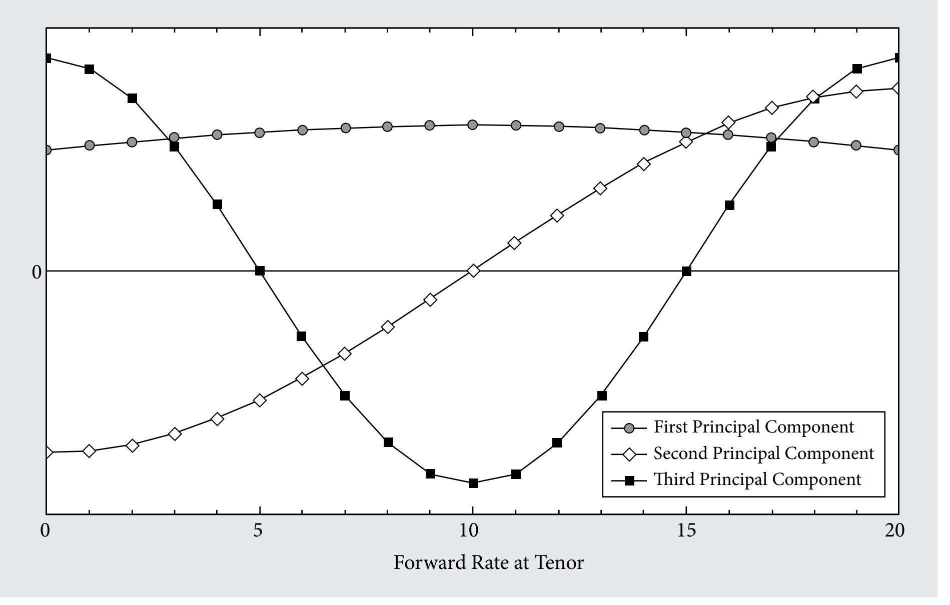

FIGURE 24.3 Largest principal components of the forward curve—parallel shift, twist, and buckle

Figure 24.3 displays a typical principal component analysis showing the first three principal components of a covariance matrix describing forward rates. The largest contributor is a linear combination of LIBOR rates with all positive contribution of comparable magnitude. It represents parallel shifts of the yield curve. The linear combination corresponding to the second largest contributor is steadily increasing in magnitude, representing a twist effect. The third largest contributor changes sign twice and is known by various names such as buckle or shape effect.

Path Generation

The final step in the Monte Carlo process is to generate correlated random numbers and construct the arbitrage-free paths of the future observable rates. On each path, the prepayment model and associated auxiliary models are used to compute the prepayment speeds and cash flows based on the simulated rates. Choosing a large number of paths is desirable, but this choice must be balanced against the constraint that the pricing calculation needs to complete in a reasonable time. This is a particular concern in the analysis of mortgage-backed securities, since computing the cash flows on each individual path takes a relatively long time due to the complex relationship between interest rates and prepayments. Furthermore, in the case of CMOs, the cash flow waterfall (which is itself path-dependent) must be applied along each path.

Since Monte Carlo is a statistical technique, the resulting price has a distribution. Each simulation (performed using a different set of random numbers) results in a different

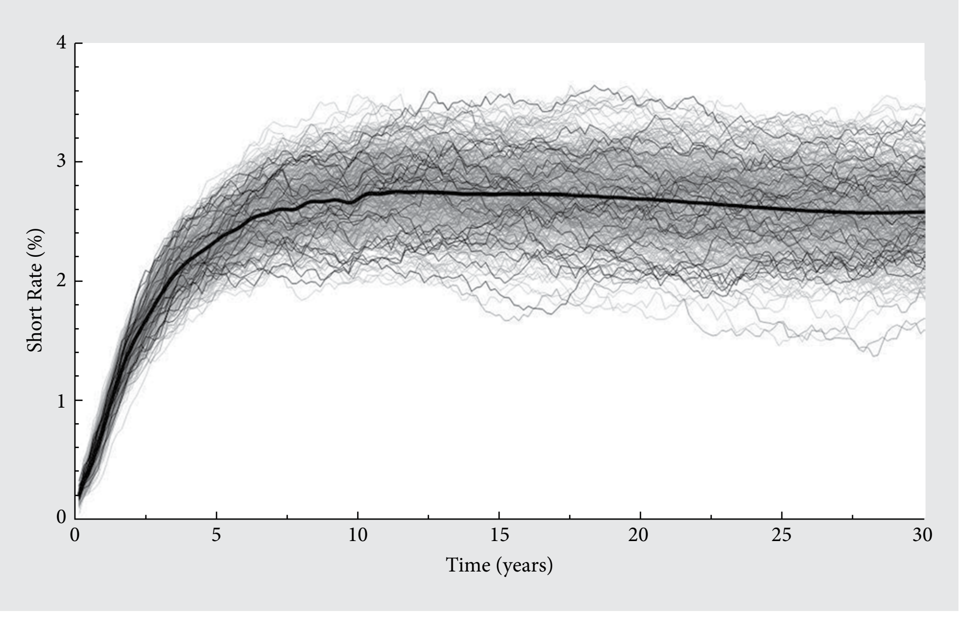

FIGURE 24.4 Monte Carlo paths of the instantaneous forward curve generated using the Hull–White model

price. Therefore, the estimated price has an associated variance that can be reduced in two ways. Increasing the number of paths reduces the variance, but as mentioned above, increases the run time. Alternatively, there exist methodologies that can produce a more accurate result for a given number of paths. Collectively, these methodologies are known as *variance reduction techniques*. These techniques typically use knowledge of the specific problem under consideration. However, there is one variance reduction technique that can be applied to any Monte Carlo problem: for every vector of random numbers used to generate a Monte Carlo path, generate the complement of this path by using the negative of the original random numbers. This eliminates any bias in the paths that could be introduced by the random nature of the sampling process.

Figure 24.4 shows the instantaneous forward rate curve and possible interest rate paths for the model used in the valuation example presented at the end of this chapter. The figure shows the potential dispersion of the instantaneous forward rate over time that is produced by a Monte Carlo model.

Option-Adjusted Valuation Metrics

Given a methodology for producing Monte Carlo interest rate paths and a prepayment model as described earlier, we can produce MBS analytics that account for the dynamic evolution of interest rates and the optionality embedded within an MBS.

Option-Adjusted Spread

Using the prepayment model, the security cash flows are determined on each Monte Carlo path. The *option-adjusted spread* (OAS) is then defined as the unique spread over the forward rates on each path that is required for the option pricing model to reproduce the market observable price, as shown in equation (11).

$$Market\ Price = E\left[\sum_{n=1}^{N} \frac{CF_n}{\Pi_{m=1}^{n}(1+f_m+OAS)}\right] \tag{11}$$

The expectation in equation (11) is computed over the distribution of interest rate paths and the cash flows in the numerator are path-dependent. OAS is computed iteratively by starting with an initial guess and adjusting it until the resulting price matches the market price to within some tolerance.

The OAS in equation (11) and the z-spread in equation (8) differ because the OAS is added on each interest rate path in the Monte Carlo simulation, whereas the z-spread is calculated over a single path of the current expectations of forward rates. The OAS accounts for the impact of interest rate volatility and the possibility that the cash flows change in differing interest rate environments, as dictated by the prepayment model.

When the assumed volatility of interest rates is zero, then the optionality defaults to a single path. In this case, the OAS is the z-spread. For this reason, the z-spread is also sometimes referred to as the zero vol OAS. The difference between the z-spread and the OAS is the option cost, as shown below:

$$Option\ Cost = Z\text{-}Spread - OAS \tag{12}$$

A positive option cost (expressed in yield or spread terms, as given in equation (12)), implies that the issuer (or mortgagor, in the case of an MBS) has the rights associated with the optionality, whereas a negative option cost implies that the investor has the rights associated with the optionality. Mortgage-backed securities generally have non-negative option cost, since the investor is short of the prepayment option.

OAS is a useful indicator of relative value and excess returns over Treasury securities or swaps, and is a key tool that is widely used by investors for deciding whether an MBS is rich or cheap versus historical levels or versus other bonds. It is a significant improvement over the static valuation metrics described earlier. Nevertheless, investors should keep in mind that OAS is an extremely model-dependent valuation metric. This should be clear from the large number of assumptions and steps that go into its calculation. The strong model dependence means that the excess return implied by the OAS will not be precisely realized in practice unless all of the model assumptions are realized, which is, of course, extremely unlikely. Model dependence also implies that the OASs produced by different models are extremely unlikely to match each other. Therefore, OAS comparisons should be made only within a specified modeling framework, never across different modeling frameworks.

Effective Duration and Effective Convexity

Duration has two basic flavors, defined by the treatment of cash flows. As mentioned above, traditional measures of interest rate sensitivity, such as modified duration, assume that the cash flows remain unchanged when yields change—these metrics are therefore unsuitable for the analysis of mortgage-backed securities. On the other hand, *effective duration* (also known as option-adjusted duration) is computed using simulated Monte Carlo paths and therefore accounts for the change in the cash flows (based on the prepayment model) under the shocked rate scenarios.

The effective and modified durations are generally close for securities whose cash flows do not change with interest rates, such as noncallable fixed-rate bonds, and where the interest rate curve is flat. However, for securities with optionality, rational issuers (or mortgagors, in the case of MBS) will alter their decisions based on interest rates and exercise the option when it is beneficial. The driver of the difference between the effective and modified durations for MBS is the interest-rate-sensitive nature of prepayment dynamics.

The procedure for computing effective duration is as follows. The OAS is first computed based on the market price of the bond. Then, the interest rate curve is shocked up by adding a fixed number of basis points, Δr, to the entire term structure of interest rates. The shifted interest rate curve is then used with the arbitrage-free term structure model to generate a new set of Monte Carlo paths and associated cash flows. The bond is then repriced using these new Monte Carlo paths, holding OAS constant. Subsequently, the interest rate curve is shocked down by the same number of basis points, new Monte Carlo paths are generated, and the bond is again repriced. Effective duration is then defined as follows:

$$\textit{Effective Duration} = \frac{V_- - V_+}{2V_0 \Delta r} \tag{13}$$

where V_0 is the price of the bond based on the prevailing yield curve and V_- and V_+ are the prices of the security when yields are respectively shifted down and up by Δr.

Duration is a linear measure, and therefore the predicted price change is a good approximation to the true price change for small shifts in interest rates. However, for larger interest rate shifts, the linear approximation breaks down and we must introduce a second-order, or parabolic, correction. This second-order correction is known as convexity. For securities with positive convexity, the linear approximation underestimates the price increase when rates fall and overestimates the price decrease when rates rise. Conversely, for securities with negative convexity, the linear approximation overestimates the price increase when rates fall and underestimates the price decrease when rates rise.

Effective convexity is calculated by an identical process to the one that is used to calculate effective duration (i.e., the interest rate curve is shifted up and down by a fixed number of basis points and the full recalculation of the security price is performed using the option pricing model). Effective convexity is defined as follows:

$$Effective\ Convexity = \frac{V_{+} - 2V_{0} + V_{-}}{V_{0}\Delta r^{2}} \tag{14}$$

Extensions to Effective Duration

Effective duration is widely used by investors to gauge the interest rate sensitivity of bonds with embedded options. However, it makes a number of assumptions that can limit its utility. First, it represents the sensitivity to a parallel shift of the yield curve. The calculation of effective duration also assumes that volatilities and OAS remain fixed when rates change. But in practice, the yield curve may change in much more unpredictable ways and may be accompanied by changes in volatility, spreads, and other drivers of MBS valuations.

The option-adjusted valuation approach described above can be used to compute many different kinds of price sensitivities beyond a parallel curve shift. The methodology is similar to the one that is used to compute effective duration, described in equation (13). That is, a particular factor is shocked up and down, new Monte Carlo paths are generated, and the bond is repriced. The *effective duration with respect to a factor F* is given by the following:[8]

$$Effective\ Duration\ w.r.t. factor\ F = \frac{V_{-}^{F} - V_{+}^{F}}{2V_{0}\Delta F} \tag{15}$$

where V_{-}^{F} and V_{+}^{F} are the values of the security when the factor *F* is respectively shifted down and up by ΔF units.

Equation (15) can be used to compute *partial* or *key rate effective durations* (KRD) by shocking individual tenors or sections of the yield curve while the rest of the curve is held constant. Exposure to other types of yield curve movements such as twist and buckle can also be computed using this methodology. Moreover, price sensitivities to factors beyond interest rate levels can also be calculated. For instance, volatility duration is the sensitivity of price to changes in the interest rate volatility assumptions that are used in the generation of the simulated Monte Carlo paths. Likewise, *spread duration* can be computed by perturbing only the bond's OAS, holding all else constant.

What about the valuation impact of the model assumptions themselves? As discussed earlier in this chapter, third-party prepayment models are, to a large extent, a "black box" from the user's perspective, introducing another element of uncertainty into mort-

[8] The sign of effective duration with respect to a specific factor may be different across analytics platforms, depending on whether the numerator is defined as the downshift price less the upshift price (as we have defined here) or the converse.

gage valuations. The model documentation generally provides only a high-level description of the model structure, assumptions, and drivers. As such, a complete view of mortgage valuation should include an assessment of the sensitivity of valuations to projected speeds, which can provide useful insight into the model dynamics. *Prepayment model durations* can be computed to measure the sensitivity of valuations to individual submodels, such as turnover, rate-driven refis, or cashout refis, or to individual drivers, such as credit score or HPA. Prepayment model durations provide a more dynamic view of the model, and may also expose model limitations or errors that should be taken into account when valuing bonds and making relative value assessments.

An Illustrative Example

It is useful to pull together the analytical framework described above with a "simple" example. The emphasis here is on how the pieces of the valuation methodology fit together so that the interested reader can follow along in a spreadsheet. We therefore make a number of simplifying assumptions to focus on the methodology and key concepts without getting bogged down in the complexity that arises in MBS valuation in the real world.

Our example is based on a simple sequential CMO off of a hypothetical mortgage pool. The pool has the characteristics listed in Table 24.2. For simplicity, we restrict the term of the pool to be just 12 periods.

The CMO has a two-tranche, sequential structure that can be summarized as "IF A is outstanding, THEN pay A, ELSE pay B." In other words, all principal payments are diverted to tranche A until it is fully paid down, after which B receives all principal payments. The coupons on both the A and B tranches are set to 7.0% (the same as the net weighted-average coupon (WAC) on the mortgage pool) so that there are no residual interest payments. The original mortgage pool and the A and B tranches are priced at $104.00, $104.25, and $104.50, respectively.

Our prepayment model consists of a simple S-curve of the following form:

$$\%CPR = \frac{Max\ Value}{1 + e^{(Elbow - Slope \times Rate\ Incentive)}} + Min\ Value \tag{16}$$

where $Min\ Value$ and $Max\ Value$ are 7% CPR and 50% CPR, respectively, and $Slope$ and $Elbow$ are set to 2.5× and 4%, respectively. The rate incentive is defined simply as the gross WAC on the pool less the new-money mortgage rate, where the new-money mortgage

Table 24.2 Characteristics of the hypothetical mortgage pool

Original Balance	Term	Gross WAC	Servicing Fee + G-Fee	Net WAC
$100 million	12 periods	7.5%	50bp	7.0%

rate is assumed to be the relevant long rate plus 100bp. For simplicity, we assume that there is no lag between loan application and closing, so that prepayment speeds and cash flows on the pool respond immediately to a change in the primary mortgage rate in any given period. The S-curve also shows no dependence on weighted-average loan age, so the pool shows the same responsiveness over time.

Our Monte Carlo simulation is based on just five hypothetical interest rate paths, as shown in Table 24.3. The table also shows forward rates computed off of the hypothetical spot interest rate curve. The "short rate" refers to the one-period forward LIBOR rate and the long rate refers to the ten-period forward swap rate. The interest rate paths are generated using the Hull–White model of interest rates described earlier. Random numbers are drawn from a normal distribution, which are then used to evolve the short and long rates. On average, these paths will reproduce the forward prices of zero coupon bonds, guaranteeing that the initial term structure is accurately reproduced. The full methodology for generating these paths is beyond the scope of this example.

The process to produce selected static and dynamic valuation metrics is summarized below:

1. Generate a number of short and long interest rate paths.
2. For each path,
   a. Determine the cash flows along this path:
      i. Compute prepayment speed.
      ii. Compute pool-level scheduled and prepaid principal payments and interest payments.
      iii. Compute the principal and interest payments to tranche A and tranche B.
   b. Discount cash flows using the forward short rates plus an initial guess for OAS to obtain the price on this path.
3. Use Excel's Solver to back out the yield and z-spread based on the cash flows along the forward path of interest rates.
4. Use Excel's Solver to back out the OAS which makes the computed average price across all Monte Carlo paths equal to the market price of the security.

To illustrate the methodology outlined above, Tables 24.4 and 24.5 show how the z-spread (over the forward curve) is calculated on the original mortgage pool and on the A and B tranches. Table 24.4 shows the principal and interest cash flows on the MBS pool in each period. Based on the S-curve given in equation (16), the table shows the expected prepayment rate in each period. The total cash flow on the MBS pool in each period is the sum of the scheduled and prepaid principal payments and the interest payments net of the servicing and guarantee fees.

Table 24.5 starts on the left with the total cash flow from the mortgage pool that is available for distribution to the CMO classes. This cash is distributed to the CMO classes per the rules governing the priority of payments. Excel's Solver is used to determine the value of the z-spread for the MBS pool and for each CMO tranche that makes the computed

Table 24.3 Short-rate and long-rate Monte Carlo paths and forward rates

	Short-Rate Paths (Forward Rates)						Long-Rate Paths (Forward Rates)					
Period	Path 1	Path 2	Path 3	Path 4	Path 5	Forwards	Path 1	Path 2	Path 3	Path 4	Path 5	Forwards
1	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%
2	4.7%	2.9%	1.6%	4.6%	0.4%	1.9%	9.4%	6.7%	5.1%	9.1%	3.8%	5.5%
3	6.8%	4.8%	1.7%	7.8%	–0.4%	2.9%	11.9%	8.8%	4.8%	13.7%	2.5%	6.1%
4	7.6%	5.8%	3.6%	4.8%	–0.9%	3.7%	12.5%	9.7%	6.7%	8.2%	1.6%	6.5%
5	7.8%	8.4%	4.1%	4.4%	–0.5%	4.3%	12.4%	13.5%	6.9%	7.3%	1.7%	6.9%
6	9.4%	7.7%	4.3%	5.0%	0.0%	4.7%	14.9%	11.8%	6.8%	7.7%	2.0%	7.1%
7	9.3%	8.3%	3.8%	4.1%	2.4%	5.1%	14.3%	12.6%	6.0%	6.3%	4.3%	7.3%
8	9.7%	7.7%	1.3%	5.5%	3.8%	5.3%	14.6%	11.3%	3.0%	7.9%	5.8%	7.4%
9	10.0%	9.5%	3.4%	5.8%	3.5%	5.5%	15.0%	14.1%	5.2%	8.2%	5.3%	7.5%
10	10.1%	9.2%	3.9%	5.5%	3.4%	5.7%	15.0%	13.4%	5.7%	7.7%	5.0%	7.5%
11	9.7%	8.0%	4.0%	6.0%	4.1%	5.8%	14.2%	11.2%	5.6%	8.3%	5.8%	7.5%
12	7.3%	8.0%	2.9%	6.2%	5.2%	5.8%	10.1%	11.2%	4.4%	8.5%	7.2%	7.5%

Table 24.4 Cash flows on original MBS pool along forward interest rate path

Period	Starting Balance	Scheduled Principal	CPR	Prepaid Principal	Total Principal	Interest	Servicing/ G-Fee	Total CF	1 + Short Rate + Z-Spread	Discounted CF Based on Forward Curve + Z-Spread	Ending Balance
1	$100,000,000	$5,427,783	36.73%	$34,738,770	$40,166,553	$7,500,000	$500,000	$47,166,553	103.73%	$45,470,921	$59,833,447
2	$59,833,447	$3,691,573	16.37%	$9,189,571	$12,881,144	$4,487,509	$299,167	$17,069,485	104.94%	$15,680,652	$46,952,303
3	$46,952,303	$3,318,867	9.50%	$4,143,110	$7,461,977	$3,521,423	$234,762	$10,748,638	105.91%	$9,322,679	$39,490,326
4	$39,490,326	$3,229,012	7.82%	$2,834,234	$6,063,246	$2,961,774	$197,452	$8,827,569	106.68%	$7,176,805	$33,427,080
5	$33,427,080	$3,199,875	7.34%	$2,220,009	$5,419,884	$2,507,031	$167,135	$7,759,780	107.29%	$5,880,298	$28,007,196
6	$28,007,196	$3,187,228	7.18%	$1,782,706	$4,969,934	$2,100,540	$140,036	$6,930,438	107.75%	$4,874,077	$23,037,262
7	$23,037,262	$3,180,176	7.12%	$1,413,231	$4,593,407	$1,727,795	$115,186	$6,206,015	108.10%	$4,037,411	$18,443,855
8	$18,443,855	$3,175,381	7.09%	$1,082,147	$4,257,528	$1,383,289	$92,219	$5,548,598	108.37%	$3,330,989	$14,186,327
9	$14,186,327	$3,171,602	7.07%	$779,163	$3,950,765	$1,063,975	$70,932	$4,943,808	108.56%	$2,733,905	$10,235,562
10	$10,235,562	$3,168,292	7.07%	$499,550	$3,667,842	$767,667	$51,178	$4,384,331	108.69%	$2,230,588	$6,567,720
11	$6,567,720	$3,165,166	7.07%	$240,502	$3,405,669	$492,579	$32,839	$3,865,409	108.78%	$1,807,795	$3,162,052
12	$3,162,052	$3,162,052	7.07%	$ -	$3,162,052	$237,154	$15,810	$3,383,395	108.84%	$1,453,880	$ -
						100 × Sum of Discounted Cashflows ÷ Face Value =				**$104.00**	

Table 24.5 Cash flows on tranche A and tranche B along forward interest rate path

	MBS Pool	Tranche A							Tranche B						
Period	Total Cash Available for Distribution	Starting Balance	Principal	Interest	Total CF	1 + Short Rate + Z-Spread	Discounted CF Based on Forward Curve + Z-Spread	Ending Balance	Starting Balance	Principal	Interest	Total CF	1 + Short Rate + Z-Spread	Discounted CF Based on Forward Curve + Z-Spread	Ending Balance
1	$47,166,553	$60,000,000	$40,166,553	$4,200,000	$44,366,553	103.47%	$42,877,398	$19,833,447	$40,000,000	$ -	$2,800,000	$2,800,000	103.67%	$2,700,841	$40,000,000
2	$17,069,485	$19,833,447	$12,881,144	$1,388,341	$14,269,485	104.69%	$13,173,033	$6,952,303	$40,000,000	$ -	$2,800,000	$2,800,000	104.89%	$2,575,027	$40,000,000
3	$10,748,638	$6,952,303	$6,952,303	$486,661	$7,438,964	105.66%	$6,499,569	$ -	$40,000,000	$509,674	$2,800,000	$3,309,674	105.86%	$2,875,338	$39,490,326
4	$8,827,569	$ -	$ -	$ -	$ -	106.43%	$ -	$ -	$39,490,326	$6,063,246	$2,764,323	$8,827,569	106.63%	$7,192,541	$33,427,080
5	$7,759,780	$ -	$ -	$ -	$ -	107.03%	$ -	$ -	$33,427,080	$5,419,884	$2,339,896	$7,759,780	107.23%	$5,896,360	$28,007,196
6	$6,930,438	$ -	$ -	$ -	$ -	107.49%	$ -	$ -	$28,007,196	$4,969,934	$1,960,504	$6,930,438	107.69%	$4,890,006	$23,037,262
7	$6,206,015	$ -	$ -	$ -	$ -	107.85%	$ -	$ -	$23,037,262	$4,593,407	$1,612,608	$6,206,015	108.05%	$4,052,767	$18,443,855
8	$5,548,598	$ -	$ -	$ -	$ -	108.11%	$ -	$ -	$18,443,855	$4,257,528	$1,291,070	$5,548,598	108.31%	$3,345,438	$14,186,327
9	$4,943,808	$ -	$ -	$ -	$ -	108.30%	$ -	$ -	$14,186,327	$3,950,765	$993,043	$4,943,808	108.50%	$2,747,222	$10,235,562
10	$4,384,331	$ -	$ -	$ -	$ -	108.44%	$ -	$ -	$10,235,562	$3,667,842	$716,489	$4,384,331	108.64%	$2,242,643	$6,567,720
11	$3,865,409	$ -	$ -	$ -	$ -	108.53%	$ -	$ -	$6,567,720	$3,405,669	$459,740	$3,865,409	108.73%	$1,818,529	$3,162,052
12	$3,383,395	$ -	$ -	$ -	$ -	108.58%	$ -	$ -	$3,162,052	$3,162,052	$221,344	$3,383,395	108.78%	$1,463,287	$0
		100 × Sum of Discounted Cashflows ÷ Face Value =					**$104.25**			**100 × Sum of Discounted Cashflows ÷ Face Value**				**$104.50**	

Table 24.6 Static and dynamic valuation metrics on CMO classes and underlying pool

	MBS Pool	Tranche A	Tranche B
Yield (%)	5.72	3.90	6.21
WAL (periods)	3.8	1.4	7.4
Z-spread (bp)	303	277	297
OAS (bp)	213	230	189
Option Cost (bp)	90	47	109

price along the forward curve equal to the market price.[9] The OAS is the spread that makes the *average price across all paths* equal to the market price and is computed in a similar fashion using the five Monte Carlo paths.

Table 24.6 lists the results of our analysis, i.e., the yield, WAL, z-spread, option-adjusted spread, and option cost for the mortgage pool and the two CMO tranches. The exhibit omits rate sensitivity measures, but the methodology can easily be extended to produce effective duration and effective convexity by shifting the yield curve up and down, generating new Monte Carlo paths, and repricing the bonds as described above. Likewise, the methodology can also be extended to gauge sensitivity to specific tenors on the yield curve, volatilities, prepayment rates, or other drivers of valuation.

The table suggests that from a yield perspective, tranche B is the most attractive. However, tranche B has the longest WAL, so the higher yield could be "fair" compensation for longer maturity cash flows. As mentioned above, the z-spread is a better measure of value than yield and nominal spread in the case of bonds that return principal over time. From the perspective of z-spread, the mortgage pool itself is the most attractive security. However, some of that z-spread is fair compensation for the optionality that is embedded within the original mortgage pool. The exhibit gives an indication of how the optionality is distributed across the CMO classes. The option cost on the original mortgage pool is 90bp, but most of the prepayment risk is transferred via the deal structure to tranche B, which makes sense given its subordinate status in terms of priority of principal payments. The OAS, which measures the spread independent of term and optionality, suggests that tranche A is the most attractive investment.

Does this mean that Tranche A is a screaming buy? Unfortunately, the answer is a definite maybe. The savvy MBS investor uses the full range of available analysis tools and valuation metrics and develops an intuition as to the weaknesses and strengths of the underlying models. The successful investor anticipates the unpriced factors in the model and trades ahead of the derived analytics.

[9] The discount rates are computed using the elements in the columns labeled "1 + Short Rate + Z-Spread." For example, to discount the *n*th cash flow, the appropriate discount rate is the product of the first *n* elements of this column.

Key Points

- A debt instrument with fixed cash flows, such as a noncallable corporate bond or Treasury, can be easily priced as the sum of its discounted cash flows. But the valuation of an MBS is more complex because the monthly cash flows are nondeterministic.
- Forecasting MBS prepayment speeds and, in turn, total cash flows, is a much more complex undertaking than predicting the timing of redemption of a callable corporate bond. Practitioners generally rely on econometric prepayment models, and associated auxiliary models, to generate speed and cash flow forecasts, which are then used to value the bond.
- The traditional static valuation metrics are of limited value in analyzing mortgage-backed securities and can lead to unreliable assessments of relative value across much of the MBS universe.
- Monte Carlo simulation is the only viable methodology for valuing mortgage-backed securities, as closed-form solutions are unavailable, and the path-dependent nature of the embedded prepayment option generally precludes the use of lattice-based approaches.
- The first step in Monte Carlo simulation is choosing a model of interest rates. There are many choices, but the LIBOR Market Model is one of the most widely used models, as it is calibrated based on observable market instruments and has the ability to reproduce complex interest rate dynamics.
- OAS is a significant improvement over the static valuation metrics and is widely used by investors for deciding whether a mortgage-backed security is rich or cheap versus historical levels or versus other bonds. Nevertheless, investors should keep in mind that OAS is an extremely model-dependent valuation metric. This means that the excess return implied by the OAS will not be precisely realized in practice unless all of the model assumptions are realized, which is extremely unlikely.
- Traditional closed-form duration measures, such as modified duration, cannot be used to gauge the sensitivity of MBS prices to interest rates, since the cash flows themselves are dependent on interest rate levels. Effective duration and effective convexity account for the dynamic nature of the cash flows and are the correct way to gauge interest rate sensitivity. Likewise, the methodology can also be extended to gauge the sensitivity to other drivers of valuation.
- It is important to understand the strengths and weaknesses of the different valuation metrics, while keeping in mind that there is no single best measure of value. The savvy MBS investor uses the full range of available analysis tools and valuation metrics and develops an intuition of the weaknesses and strengths of the underlying models. The successful investor anticipates the unpriced factors in the model and trades ahead of the derived analytics.

CHAPTER 25

MODELING PREPAYMENTS AND DEFAULTS FOR MBS VALUATION

JONATHON WEINER

AFTER reading this chapter, you will understand:

- why taking a position on MBS requires a high-quality prepayment/default model;
- that loan-level models are intrinsically more capable of differentiating MBS values;
- why traditional econometric techniques frequently fail to predict mortgage behavior;
- which factors cause borrowers to move, refinance, and default;
- how recent changes to the mortgage industry affect MBS holders;
- that burnout, once regarded as a secondary effect, critically impacts the value of MBS;
- how an option-adjusted framework more fully characterizes MBS cash flows.

Mortgage-backed securities are bonds whose cash flows derive from the collective payments made by a pool of mortgage borrowers. Embedded in those mortgages are two options—the option to pay off the loan prematurely and the option to default on it. The uncertainty in how these options will eventually be exercised causes mortgage-backed securities to produce cash flows and ultimately values which are undetermined at the time of issue. These features mean that understanding the behavior of mortgage borrowers is a critical component of MBS investment.

The option to prepay a mortgage is typically exercised when a borrower sells their house or when they refinance their mortgage. Since a borrower will generally refinance to lower their mortgage rate, an investor winds up receiving principal early when interest rates have fallen and they are forced to reinvest at a lower rate. If rates rise however, the investor is stuck with the stated coupon's yield. This asymmetry means that the prepayment option, which the investor is short, has a positive value. Borrowers also can default on their mortgage and they tend to do so only when the value of their property is below the amount they owe. For most non-agency mortgage-backed securities, the associated loss will be passed directly to investors. However, in all cases, a defaulted mortgage is removed from the pool and its payments cease.

What makes projecting MBS cash flows so difficult is that both of these options are exercised inefficiently—not all premium mortgages will refinance and not all underwater mortgages will default. The challenge then is to predict at what rate the borrowers in the pool will prepay and default. Any method which forecasts these rates quantitatively can be thought of as a prepayment and default model.

It is worth noting that while models are frequently estimated relative to a data sample containing some historical patterns of prepayment and default, I refer here to a model as something more fundamental—it is the mechanism by which statements are made about future mortgage behavior. Thus, the only metric of any importance which characterizes model quality is how well it forecasts future out-of-sample prepayments and defaults. Let us not be confused into thinking that the modeler's job is to predict the past.

The Economic Environment

In practice, most models assume that certain variables which describe the future economic environment are known. In this sense, the model doesn't predict rates of prepayment or default, but rather it specifies the relationship between those rates and other trends in the larger economy.

A full projection of interest rates is almost universally taken as one of those known economic variables for several reasons. First, the rate of refinance has an obvious and critical dependence on the interest rate path. Without this input, models would have little to say about timing and magnitude of refinance. Second, there currently exist well-developed theories of interest rate movements, along with methods to calibrate possible scenarios to current market yields and volatilities. These interest rate processes (IRPs) are Monte Carlo simulations of future interest rate paths which are consistent with the term structures and volatilities of interest rates and can be used as model inputs. Finally, a liquid interest rate derivative market provides efficient hedges for any interest rate risk that can be quantified. In this way, the hedged investor of mortgage-backed securities is sensitive to the accuracy of their model, but takes no position on the path of interest rate movements. For these reasons, the modeler of prepayments and defaults can effectively treat interest rates as a known input variable.

House price appreciation (HPA) rates are also frequently included as model economic drivers, typically at a geographic granularity of state, core-based statistical area (CBSA), or ZIP code. Like the effect of rates on refinance, declining house prices drive defaults through an obvious mechanism. There is also some consensus on how basic economics and demographics drive house price growth and a corresponding ability to forecast realistic scenarios of house price appreciation. Unlike with interest rates, there is currently no liquid market for house price appreciation derivatives. The implication is that MBS investors are dependent not only on the quality of their model, but also on their ability to forecast HPA. Still, the increase in clarity achieved by separating out this crucial driver makes up for the difficulty in forecasting house prices.

In addition to interest rates and house prices, several other unhedgeable economic variables are frequently taken as prepayment and default model inputs. These may include indicators of the general economy such as the unemployment rate as well as market structural components such as the spreads between various mortgage rates and underlying risk-free rates, mortgage eligibility standards and the existence of targeted refinance programs, and timelines and costs associated with liquidating defaulted mortgages. Since the forecast of these variables generally falls outside the realm of prepayment and default modeling, their assumed values are usually made explicit so that a model user has the ability to express their own opinions in a straightforward way.

The Data for Loans Backing Securities

Almost without exception, the issuers of mortgage-backed securities release data which describes the loans backing a given pool or collateral group. Included are fields related to the terms of the mortgages, the creditworthiness of the borrowers, the character of the properties, and the monthly history of actions occurring on the mortgages.

The terms describing how the loan is to be repaid are generally well documented and include loan amount, date of origination, lien, penalty, term, and fields necessary to calculate coupon and payment resets including interest-only and negative amortization components where applicable. Given an interest rate scenario, these fields allow for the calculation of a full schedule of monthly mortgage payments and rates which helps to quantify important drivers like amortized loan balance, incentive (difference between loan coupon and prevailing mortgage rates), and payment shock.

Some of the data elements related to the creditworthiness of the borrowers that were used to underwrite the mortgages are passed along to the investor. Frequently included are the borrowers' credit scores, the purposes for which they obtained the loans, their debt-to-income ratios, the number of borrowers on the loans, whether they are a first-time homebuyer, how they intend the properties to be occupied, the channel through which they obtained the loans, and the completeness of their submitted documentation. Although not usually provided, the spread-at-origination (SATO) can be calculated as the difference between the borrowers' coupons and prevailing mortgage rates at the time of origination. The loan product chosen by the borrowers also yields information describing their risk preferences. Together, these credit-related fields help indicate how likely the borrowers are to miss payments, and for how long they intend to remain in the houses.

The location, dwelling type, and value of the properties backing the mortgages are almost universally disclosed as well. Depending on the issuer, different levels of geography are used to describe the property locations. These may be as coarse as state, or may include CBSA, county, or ZIP code. The properties' values are typically released in the form of a loan-to-value ratio (LTV) and describe either sale prices (for purchase-originated loans) or appraised values. These inputs are critical in calculating an updated LTV by adjusting original property value for local house price appreciation and loan balance for amortization. LTV is necessary for models to estimate when borrowers are underwater or eligible to refinance.

In addition to the at-issue data, several fields are updated monthly with the loans' statuses. At a minimum, the unpaid balance defines which loans are still active and which ones prepaid or were liquidated during the prior month. Often, the next payment due date and delinquency status is released, and for some sources, modification actions and losses are described as well. When a mortgage can be linked directly to an individual borrower and property address, updated credit scores and property indicatives can be obtained. Prepayment and default models take advantage of updated information differently, depending on their structure, although in most cases the model considers only those loans which are still active, usually accounting for their current delinquency status as well, where available. Some models make use of the loans' full payment histories, not just their current statuses, to account for the increased risk of default and inability to refinance loans that have prior delinquencies.

Finally, there are a few fields that relate to how the loans were guaranteed or securitized. In most cases, this shouldn't impact how the loans behave (after all, a borrower has little control or knowledge of how their loan is funded). However, there are some instances in which the handling of defaulted loans varies depending on how they are securitized and some streamline refinance programs (HARP, FHA) whose eligibility requires specific guarantors. For these discrete criteria, models should have discontinuous response.

The Availability of Loan-Level Data

Between about 2003 and 2013, a transformation occurred regarding how data is released for the mortgages which back securities. Prior to this shift, pool-level averages of mortgage fields were reported almost exclusively, sometimes in conjunction with breakouts or quartiles for specific important variables. Today, every new issue of a mortgage-backed security releases loan-level data. While this practice has been standard for non-agency deals since the early 2000s, it has only recently been introduced for agency securities. For outstanding collateral, loan-level data is available for the vast majority of non-agency RMBS, all GNMA pools, all FHLMC pools issued since 2006, and all FNMA pools issued since 2013. In total, loan-level data covers roughly 67% of agency mortgage-backed securities as of year-end 2014, but is increasing at an approximate rate of 7% per year as new issues replace older pools.

The emergence of loan-level data is useful to prepayment and default modelers in several ways. First, it allows for the association of historical behavior with specific loan characteristics. A modeler is then able to construct cohorts of similar loans and investigate model fit relative to any available field. This was not possible when only pool-level averages were available and historical prepayments and defaults could not be tied to individual loans with definite values for a field. Second, and more importantly for valuation, it provides complete information on the distribution of loan characteristics—in particular, describing any correlations that may exist. As a result, models built using loan-level data may include a much wider set of multidimensional sensitivities.

Finally, it is worth noting that, for most models, loan-level data has eliminated the need for custom model calibrations to specific mortgage portfolios. Older generations of models that were not driven by the full set of loan characteristics typically needed adjustment when applied to alternate portfolios with slightly different traits. As a result, models proliferated. Loan-level models, in contrast, can better adapt to the peculiarities of different portfolios so that a single model may apply much more broadly.

Modeling Millions of Loans

Despite the benefits of loan-level modeling, dealing with data sets containing millions of loans can be challenging. To quantify the impact of future economic scenarios or changes to its parameters, models need to be run on-the-fly. Given that most calculations involve hundreds of months of projections, this process can be time-consuming, even with higher-end computing resources. Even single securities may contain portions of hundreds of thousands of loans, necessitating the use of some method to reduce computation time.

The most commonly used approach to reduce the execution time of a model run is to employ some form of averaging on the loan inputs. By aggregating loans into groups, the number of model calculations can be reduced to almost nothing. While the contribution of any given loan may be quite small, the average inputs can still be said to represent the total set of loans. Although simple to understand, this method suffers from serious drawbacks. The representative input values, defined as the average of many loans, contain no information on the distribution or correlation of the loan characteristics. As a result, the model projections may be biased—in other words, the model projection using average inputs may differ from the average model projection using loan-level inputs. This problem is caused by nonlinearities in the model form and makes it increasingly difficult for a modeler to support a variety of aggregation options. Furthermore, some input fields do not average well. For instance, a geographic footprint defined by a small group of selected ZIP codes is not well represented by any higher-level geography. Averages of quantities like SATO, which depend critically on the date at which a loan was originated, are easily biased as well.

A better approach to modeling large data sets is to employ sampling. Although less easily understood than averaging, random sampling is equally effective at reducing calculation time, but it is free of the biases that may affect averages. Of course, sampling introduces a new source of error to the projection, but basic statistics dictates that the size of sampling error (for an unweighted average) is given by:

$$\sigma_{mean} = \sigma_{loan}\sqrt{\frac{N-n}{n(N-1)}}$$

where σ_{loan} is the standard deviation of the loan-level model projections, σ_{mean} is the error in the mean sample projection, n is the sample size, and N is the size of the cohort. For samples on large cohorts, the sampling error ends up being inversely proportional to the square root of the number of samples. Furthermore, the standard deviation of the loan-level projections, σ_{loan}, can be empirically measured by comparing the model projections across loans. Hence, it is easy to estimate the sample size that would be needed in order to reduce sampling error below any given level. In most cases, the absence of bias inherent in this technique outweighs the minor difficulties associated with the management of sampling error.

The Limitations of Traditional Econometric Modeling Techniques

In many econometric circles, modeling is synonymous with regression analysis. There are many specific forms of regression modeling, but all involve the use of a historical data set to determine the most likely values for the free parameters of a specified model form. In practice, relatively complicated processes like mortgage prepayment and default are modeled using several equations, each having a dependent variable that describes a separable component of borrower behavior. The correlations exhibited by each dependent variable relative to a collection of independent variables (or drivers) determine the strength of the corresponding model relationships. For instance, the rate of missed payment of non-delinquent borrowers might be modeled using drivers for various borrower credit characteristics, the current loan-to-value ratio of the mortgage, and some function of the payment changes experienced. In this way, a complex set of behaviors can be broken down into a series of simplified relationships.

However, the use of regression techniques places some limits on the structures that these models may have. The class of models which can be parameterized efficiently is much smaller than the complete collection of possible models. Recursion, in which a model directly depends on its forecast for a prior period, is particularly useful for periodic forecasting. However, regression techniques generally do not support recursion because it introduces complicated nonlinear sensitivities. Mortgage behavior is widely recognized to be path-dependent, meaning that borrower prepayment and default depend not only on the current environment, but also on the historical conditions experienced by the borrower. For instance, the probability that a borrower will refinance is much lower if that same borrower passed on the opportunity to refinance last year for a larger incentive. In this example, recursion provides an elegant way for the model to ask itself whether the borrower was eligible and had incentive during prior periods.

Without recursion, burnout, as this effect is known, must be modeled using some combination of "exposure" variables which attempt to approximate the historical opportunities experienced by the borrower.

In addition to the structural limitations, there exists a more intrinsic problem associated with how regression models are commonly parameterized. Designed to extract as much information as possible from the patterns exhibited by data, regression is fundamentally incapable of answering questions concerning effects not present in the data. While an experienced modeler may use Bayesian or similar techniques to force a desired model response, this is rarely done in practice. More frequently, models consist of the minimum number of effects sufficient to satisfactorily explain the historical data set. This is a problem because the particular economic conditions on which a model is trained consist of only a single path through the entire space of possible environments. The model may perform well in backtests, where it functions as an interpolator, but will fail in the future where it is exposed to an environment which hadn't yet been observed. Of course, the models may then be re-parameterized relative to new data as it arrives, but this merely indicates that the original models were insufficient at predicting the 30 years of prepayment and default rates needed to value most mortgages. Many of the most spectacular model failings of the credit crisis were caused by this mechanism. During the era of the housing bubble, historical mortgage data was dominated by periods in which house prices steadily rose. While there was a precedent for house prices to decline (regionally, in the 1980s and early 1990s, and nationally, in the Great Depression), these periods generally fell outside the historical data set on which the models were trained. As a result, the models had no basis for predicting that the sensitivity of default rates to LTV would steepen as LTVs surpassed 100%. Nevertheless, this acceleration should have been entirely predictable given our a priori expectation that most borrowers would *only* default when they were underwater on their mortgage.

Looking Beyond Historical Data to Determine Model Structure and Parameters

The set of historical data available at the time of model building is generally capable of constraining only a portion of the model's structure. This essential fact must be acknowledged by the modeler—there will be important pieces of the model sensitivity that are undetermined by the available history. For each model factor, mortgage behavior is observed over some interval of that driver's range of values. A model, however, needs to operate over the entire range of driver possibilities. So, the modeler's job is primarily focused not on fitting the model within those historical ranges, but rather on estimating the model's form outside of those ranges. This includes extrapolating each driver response outside of the factor's observed range, but it also includes identifying the interactions that might occur between the drivers.

To accomplish this, the modeler needs to draw upon what is already known about the causes of borrower prepayment and default and the operation of the mortgage industry. This a priori understanding should command how the model is to be structured. In this sense, the process of model fitting is not about matching history, but rather about surmising the mechanisms which explain that history. Core borrower behaviors are stable and models based on them should not require frequent revision. An intuitively structured model is guaranteed to behave intuitively out-of-sample and will be much more robust to unprecedented economic environments.

Housing Turnover

Of the two embedded options within a mortgage, the option to prepay dominates the valuation for the majority of borrowers in most economic environments. Across all rate environments, housing sales are a significant driver of prepayments. Very few mortgages are assumable, so the rate at which borrowers sell their homes translates directly into a baseline level of prepayment. The housing turnover component of prepayment depends strongly on mortgage age (the number of months since origination). Borrowers with plans to move would not typically refinance their mortgage due to one-time fees. As a result, the rate of housing turnover is slow for newly originated loans and rises steadily with age, eventually reaching some plateau.

The choices that borrowers make when choosing a mortgage also provide useful indications of their inclination to move. If they have a shorter expectancy of remaining in the home, they are more likely to select an adjustable-rate mortgage (ARM) or pay a higher rate as a means of reducing their upfront points and fees. Consequently, ARMs and high-SATO mortgages experience increased home-sales-related prepayments. Housing turnover also exhibits a pronounced seasonality owing to the fact that the housing market is most active in the summer. This varies somewhat with geography with colder states experiencing larger relative declines in the winter. Housing turnover has a weak dependence on mortgage rates as well. When a borrower has a below-market mortgage rate, they are disincentivized to move, as their new mortgage would be less affordable. The housing market also exhibits its own economic cyclicality. Periods of high demand drive up house prices. The rate at which borrowers sell their homes is related to housing demand which drives house price appreciation, so these two variables end up being well correlated in a given market. Thus, for models which use house price appreciation as an economic scenario input, it can serve as a proxy for housing demand and is a strong driver of housing turnover.

Figure 25.1 shows the prepayment rate (single monthly mortality, or SMM) for a very large cohort of 2004-era GSE-backed loans along with the historical mortgage rate. These actuals are compared with a model back-test (calculated using the Zero Degrees Prepayment and Default Model and referred to simply as "the model"). The home-sales-related component is broken out for clarity. Within it, one can observe the initial aging ramp over the first two years, the peak and subsequent decline associated with the housing

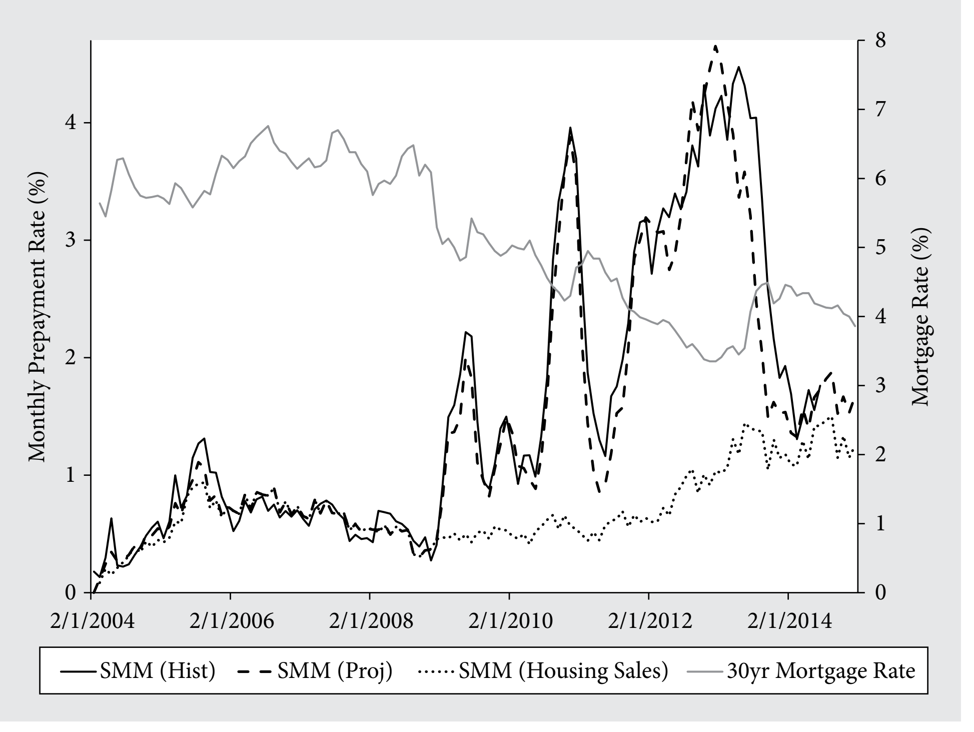

FIGURE 25.1 Model and historical prepayment rates and prevailing mortgage rates for 2004-originated, 5.5% gross coupon GSE-backed 30-year fixed mortgages

bubble, and recent increases associated with the low mortgage rates and improving housing market. By combining the effects discussed in the previous paragraph, it is not too difficult to model historical housing turnover, not just for the cohort shown in Figure 25.1, but across the entire universe of mortgages. That being said, the importance of accurately predicting housing turnover rates over the next ten years should not be understated. The era in which most prepayments have been driven by refinancing may be coming to an end, whereas for the low-rate mortgages currently outstanding, prepayments may come to be dominated by housing turnover.

Refinancing

In contrast to housing turnover, the rate at which borrowers refinance is extremely variable and critically dependent on prevailing mortgage rates. The key to understanding refinancing activity is to look at it from the borrower's perspective. Most mortgage models define an incentive function which represents how much a borrower might save by refinancing. For each borrower, there is some break-even of incentive that would trigger them to refinance. Some borrowers will refinance for a reduction of as little as 25 basis points in their mortgage rate as evidenced by sharp increases in observed prepayment rates when incentive crosses this level. However, this threshold will be higher if the borrower has higher upfront costs or expects to remain in the house for a limited length of time. The break-even incentive also depends significantly on geography and loan size as state laws and fixed costs influence the loan origination process and different classes of borrowers manage their personal finances differently. When house prices have risen substantially, the threshold incentive may even be negative if the borrower has the equity and desire to take cash out on the refinance.

The prepayment rate for a cohort of borrowers shown in Figure 25.1 reflects this structure. Refinancing was almost nonexistent for this cohort of 5.5% coupon loans until prevailing mortgage rates dropped below 5% in early 2009. A second low in late 2010 caused another set of borrowers to refinance, followed by a series of new lows in 2012 and 2013 which induced even more. It should be noted that in early 2011 refinancing almost ceased, even though prevailing mortgage rates were still below 5%. The reason is straightforward—any borrower who would refinance for that rate had already experienced several opportunities to do so. So, none of those borrowers remained in the pool. This phenomenon is known as burnout and is discussed in detail in another section.

Of course, not all borrowers are eligible to refinance. In most cases, minimum credit and income standards exist which borrowers are required to meet in order to qualify for

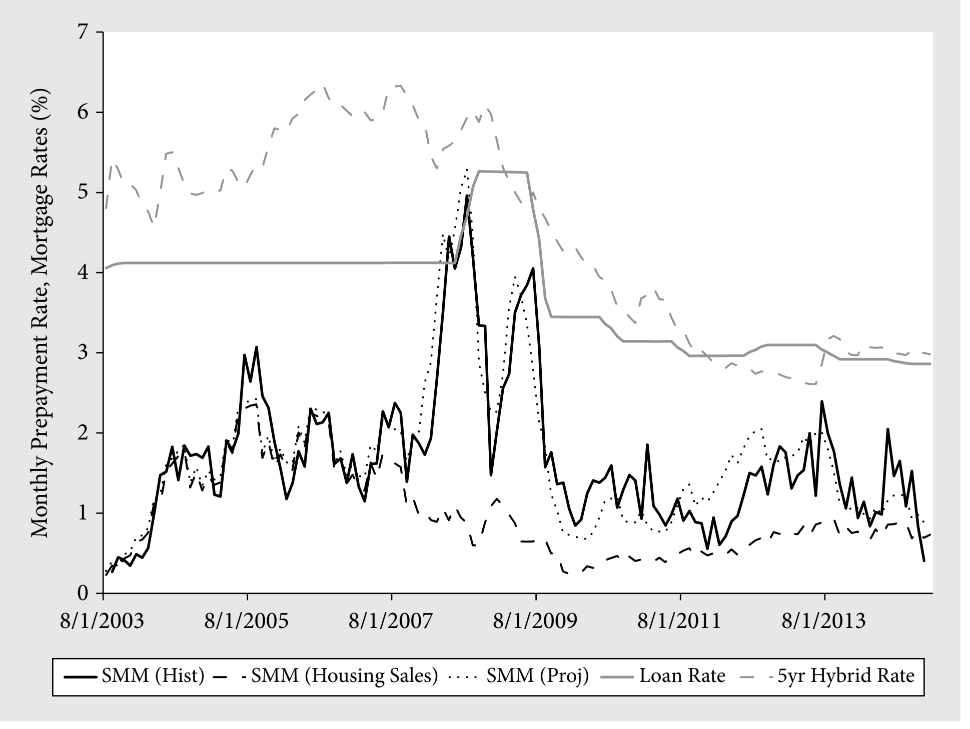

FIGURE 25.2 Model and historical prepayment rates and prevailing mortgage rates for 2003-originated, 4% gross coupon GSE-backed 5-year hybrid mortgages

a new mortgage. That the borrower met a (perhaps different) set of underwriting standards at origination does not imply that they are currently eligible. Furthermore, and especially when property values decline, the borrower may not have sufficient equity in the house to finance a new mortgage. These locked-out borrowers may constitute a small fraction of any given cohort, but they may become dominant if rates drop significantly and the remaining borrowers have mostly prepaid.

The calculation for hybrids and ARMs is similar to but more complicated than for fixed mortgages. For these loans, incentive is not simply a function of the loan's coupon and prevailing rates, but also depends upon for how long the borrower will retain their rate and the expected subsequent change in coupon. Figure 25.2 illustrates the prepayment rate of a large cohort of 2003-era 5-year hybrid loans. Over the entire 5-year fixed period, prevailing mortgage rates remained substantially higher than the loans' coupons, and for the first several years, prepayment was dominated by housing turnover. However, as the first reset approached, the borrowers began to refinance quickly (into a higher-rate mortgage). This phenomenon occurred because the borrowers were anticipating that their coupons would soon increase. The model is able to account for this effect by defining the incentive, in part based on the expected post-reset coupon. Following the reset, prepayment slowed until a drop in mortgage rates triggered another round of refinancing in 2009. The borrowers that remained in the pool subsequent to 2009 have presumably accepted the floating nature of their rate and have since prepaid slowly.

Affordability-Related Default

Along with prepayment, mortgage borrowers have the option to default. While the actual reasons that a borrower might default are quite complicated, the causes can be divided into two main categories—those caused by the inability to continue making payments (affordability-related default) and those in which the borrower chooses to stop making payments (strategic default).

Many life events may trigger an affordability-related default. This includes factors such as unexpected expenses, natural disaster, death, and divorce. The largest driver of affordability-related default, however, is job loss. As a result, a tight relationship between unemployment and missed payments is observed. The frequency of these defaults is strongly modulated by borrowers' credit profile, not just the credit score that was obtained through underwriting, but also their income, the strength of their documentation, and observables such as SATO and the choice of mortgage product. It should be noted that LTV plays only a minor role in affordability-related default. Borrowers that have equity in their property but are unable to make their payments might be able to sell or take cash out of their house to avoid default. However, a property value decline by itself does not affect a borrower's scheduled payment and therefore cannot cause an affordability-related default. Hence, its sensitivity with respect to LTV must flatten above 100%. This mechanism allows affordability-related default to be estimated separately from strategic default.

Strategic Default

With strategic default, the borrower chooses to stop making mortgage payments, presumably after making a rational decision that they would be better off with the consequences of default, which, depending on the state, may be no worse than having damaged credit for several years. In contrast to affordability-related default, strategic default does not require that the borrower is unable to make their payments. As a result, strategic default is not nearly as sensitive to credit variables and unemployment. It is, however, extremely sensitive to LTV. In fact, the benefit that a borrower receives from a strategic default is proportional to the degree to which they are underwater whereas the cost is mostly constant. Thus, we would expect some fraction of borrowers to strategically default when their LTV crosses a threshold value. After this initial spike, the rate will decay quickly, even if LTVs remain high, because those inclined to default strategically will have already been removed from the pool. This, of course, is another example of burnout.

The time dependence of affordability-related and strategic default is illustrated in Figure 25.3 which shows the monthly default rate and house price appreciation (HPA)

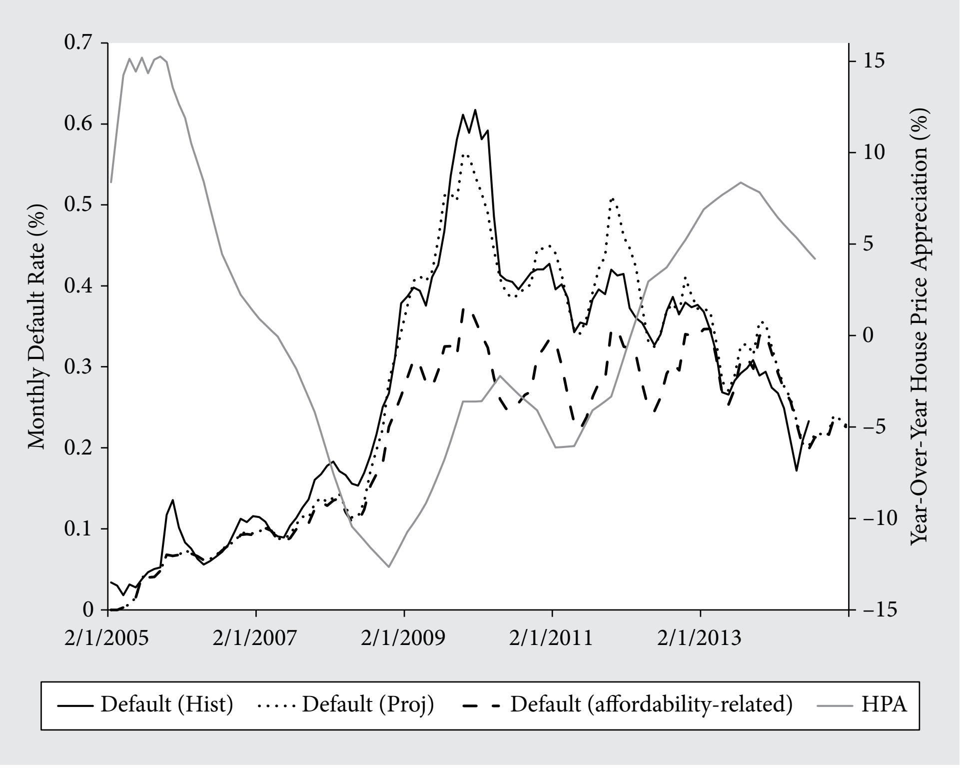

FIGURE 25.3 Model and historical default rates (defined as missing third payment) and house price appreciation for 2005-originated, 6% gross coupon GSE-backed 30-year fixed mortgages

for a large bubble-era cohort of GSE-backed mortgages. Here, default refers to borrowers missing their third payment while liquidation refers to the point when the loan is removed from the pool and a loss is passed to the investor. Initially, this cohort experiences an increase in house values and the rate at which borrowers become seriously delinquent is quite low. By the middle of 2008, the housing market had declined significantly, and defaults rose as borrowers were no longer able to sell or refinance because of their lessened equity position. At that point, unemployment was still low. When it surged in late 2008, affordability-related defaults rose even higher. By 2009, house price declines had driven many loans underwater which induced a wave of strategic default that continued into 2010 and 2011 as new house price lows were hit. By 2013, house price recoveries caused strategic defaults to evaporate and a lower unemployment rate is gradually driving down the rate of affordability-related default.

Post-Default Behavior

Once a borrower has missed several payments, a new set of factors determine how their default will play out. Before the credit crisis, most borrowers were quickly put on a path toward foreclosure. Borrowers might escape this fate by selling the property if they have equity in the house. Otherwise, the foreclosure process results in the property being acquired and sold. The timeline and costs involved in a default vary according to state laws, with judicial states typically requiring a longer foreclosure period. For non-agency RMBS, the difference between the balance and the sale price, plus the costs associated with the foreclosure process and carried interest, are passed to the investor as a loss. Agency MBS investors, by contrast, receive full repayment of principal, typically well before the property is liquidated.

Sometimes, borrowers are able to cure their delinquency and become re-performing. Following the credit crisis, many borrowers were cured by accepting loan modifications, often with significant reductions in their payments. Re-performing borrowers, by and large, behave very differently than pristine (never seriously delinquent) borrowers, and much more like low-credit borrowers. Figure 25.4 shows the monthly rates of prepayment-in-full and default for the non-agency jumbo prime universe, separated into pristine and re-performing groups. For these prime borrowers, the re-performing loans defaulted at a rate about ten times that of pristine borrowers, across all periods. The situation for prepayment is more complicated. Before the crisis, re-performing borrowers with equity prepaid (presumably selling their house or taking cash out in a refinancing). Following the crisis, this same group of borrowers (many of which were modified) had neither the equity nor the eligibility to prepay their loan and consequently prepaid very slowly (at rates well under 0.5%/month). In contrast, pristine borrowers were able to take advantage of refinancing opportunities and prepaid at rates as high as 2.5%/month.

Modeling post-default behavior involves a proper accounting of these factors. The rates at which loans cure or move through the foreclosure process will depend on state and LTV predominantly, but following the credit crisis, modifications became widely

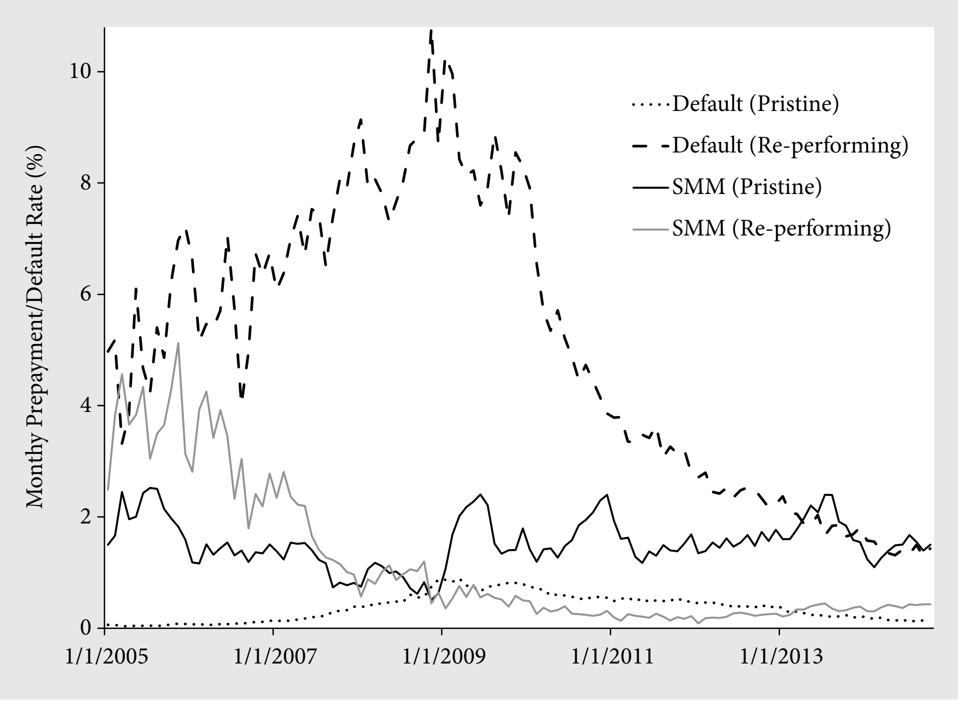

FIGURE 25.4 Average historical rates of prepayment-in-full and default (missing third payment) separately for pristine (never seriously delinquent) and re-performing (formerly seriously delinquent) loans from the universe of jumbo prime non-agency securities

available and the foreclosure process slowed. The large number of modified re-performing loans requires a model capable of accounting for their distinctive nature and the various types of modifications which lead to drastically different outcomes. Loss given default can be modeled well as the sum of its components. This includes losses from outstanding loan amount, fixed-dollar foreclosure costs, and carried interest, and a recovery of the property's value, including discounts associated with the likely deterioration in the condition of the house and the distressed nature of the sale.

A Changing Mortgage Industry

In the wake of the credit crisis of 2008, following the epidemic of foreclosures and defaults and the mortgage-related failures of several institutions, many core components of the mortgage industry were altered. These structural changes generally affected mortgage modeling in two ways. First, in response to the cessation of non-agency residential mortgage issuance and the movement toward reduced default risk for the agencies, underwriting standards for new originations were tightened and many previously eligible borrowers were no longer able to obtain mortgage financing. Second, popular support for foreclosure moratoria and access to loan modifications placed new restrictions on banks' handling of delinquent mortgages.

Mortgage Eligibility Has Tightened and Become More Complicated

In the latter half of 2007, non-agency residential mortgage securitization came to a near complete halt in the face of rising default rates. The elimination of this origination channel immediately prevented loans from being issued to most subprime and non-documented-income borrowers. It also greatly reduced the number of mortgage products, effectively removing option ARMs, interest-only loans, and 2-year hybrids. When the GSEs were put into conservatorship a year later, they too tightened their underwriting guidelines in an effort to stem future losses (and compensate for losses on their current portfolio). The average credit score, debt-to-income ratio, and down-payment for all GSE 30-year fixed-rate purchase loans are shown in Figure 25.5 as a

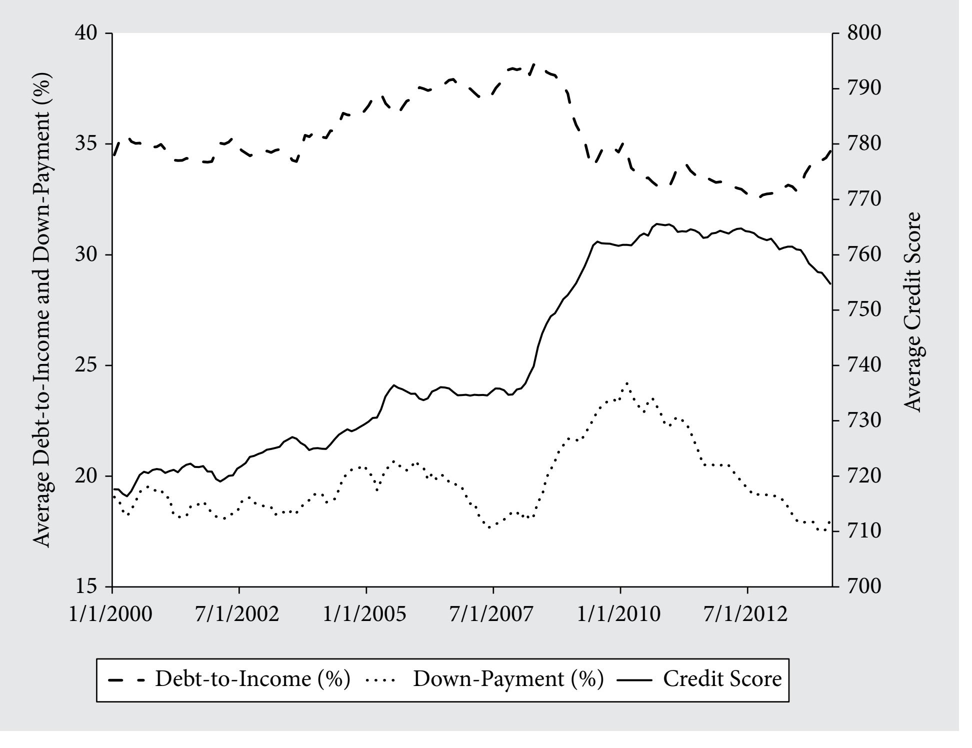

FIGURE 25.5 Average credit score, debt-to-income ratio, and down-payment (defined here as the difference between 100% and combined LTV) by date of origination for GSE 30-year fixed-rate, purchase-originated loans

function of origination date. In this context, purchase-originated loans serve as a better control group because their demand is more consistent than refinance-originated loans.

From early 2008 until mid-2009, the average credit score increased from around 735 to 765; debt-to-income, which had been elevated during the housing bubble, dropped from 38% to 33%; and down-payment (defined as the difference between 100% and combined LTV) increased from about 18% to 23%. These adjustments resulted in reduced default rates for the post-2008 vintages and a more profitable guarantee business for the GSEs, but they also resulted in many borrowers that were unable to refinance and take advantage of the low mortgage rates that occurred post-2008. In addition to the stricter underwriting standards, banks became increasingly cognizant of the put-back risk on their originations. To manage this risk, the documentation, costs, and length of time required to obtain mortgage financing all increased significantly. As a result, even for borrowers that were eligible, the incentive for which borrowers chose to refinance was higher than in pre-crisis periods.

Beyond the overall tightening of eligibility standards, a few subcategories of borrowers had even tighter constraints. Jumbo prime borrowers, in particular, were ineligible for agency guarantees, and banks tended to charge them with a higher interest rate. At the peak of crisis, this jumbo spread was more than 100 basis points relative to conforming

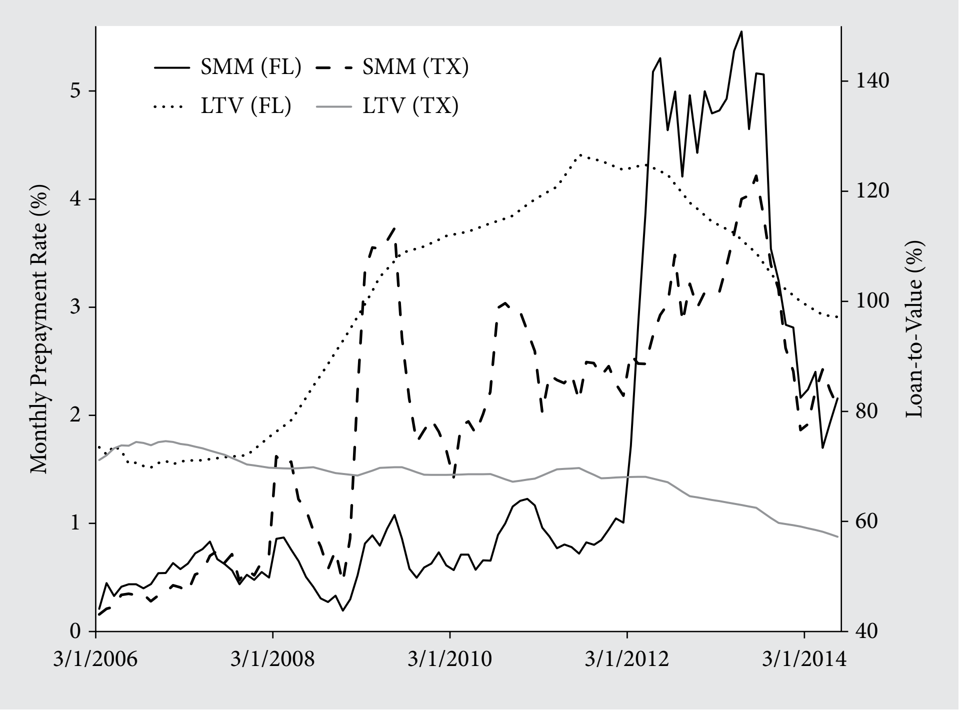

FIGURE 25.6 Prepayment rates and loan-to-value ratios for 2006-originated, GSE 30-year fixed loans, shown separately for Florida (which experienced a large house price bubble and subsequent decline) and Texas (which experienced moderate continuous house price growth)

rates. This spread reduced the incentive for borrowers whose mortgage was above the conforming limit, which was itself raised and lowered at several points for certain high-cost geographies. Other types of borrowers were able to access mortgage financing more easily. In the agency market, the GSE Home Affordable Refinance Program (HARP) and FHA streamline refinance program reduced refinance eligibility requirements for agency mortgages originated prior to June 2009.

Both programs reduced closing costs and raised the allowable LTV for a refinance. These programs were eventually extremely successful and had a huge impact on prepayment speeds. Figure 25.6 shows monthly prepayment rate and estimated current loan-to-value ratios for GSE 30-year fixed, 2006-originated collateral in two particular states. Texas experienced relatively slow and consistent house price growth over this period and as a result, the average LTV declined slowly from about 70%. The Texas borrowers were overwhelmingly eligible to refinance and took advantage of the 2009 and 2010 mortgage rate lows leading to monthly prepayment rates near 4%. In contrast, Florida experienced a large housing bubble and subsequent decline. The Florida borrowers' LTV started close to 70%, but increased to 130% during the worst of the crisis. These high-LTV borrowers were generally unable to refinance under the first incarnation of HARP in 2009, but more than half refinanced when HARP II eliminated the LTV upper limit in 2012. Many of the structural changes that took place in the mortgage industry could not have been predicted and were missing from earlier models. Nevertheless, Figure 25.6 illustrates just how important their effects can be and the corresponding need for models to respond quickly to the changing environment.

The Liquidation Process Has Lengthened and Is More Scrutinized

The other major change that occurred in the mortgage industry following the last recession was the lengthening of the nation's foreclosure and liquidation process. In the face of so many delinquent borrowers, state attorneys general imposed moratoria, and foreclosure became a more scrutinized process. To quantify the lengthening of the foreclosure process, most analysts resort to direct measurement of the number of months taken for borrowers to traverse the stages of delinquency. However, this kind of measurement can be biased because it uses a selection of loans that have already reached a given stage of the liquidation process. The unbiased way to measure time-to-liquidation uses a set of loans that became seriously delinquent concurrently. This static pool can be followed over time to see how many loans were liquidated and when this occurred. Unfortunately, this is quite impossible to measure for loans which recently became delinquent (since we have no future data for them.)

However, the transition rate matrix can be measured on a month-over-month basis to see what fraction of loans are pushed through the stages of the delinquency process. Table 25.1 shows an example of these roll rates. Note that the rows do not necessarily sum to 100% because the transitions to cured states are excluded.

Table 25.1 Average month-over-month transition matrix for non-agency first-lien securitized loans in 2014

		To State				
		60+	**Bankruptcy**	**Foreclosure**	**REO**	**Liquidation**
From State	**60+**	79.59%	0.41%	6.06%	0.17%	0.62%
	Bankruptcy	1.58%	93.09%	2.06%	0.06%	0.05%
	Foreclosure	4.34%	1.02%	89.45%	2.71%	0.49%
	REO	0.32%	0.08%	0.53%	87.36%	8.82%

To convert these roll rates into effective delinquency timelines, we can calculate the probability and expected length of time for a loan in each delinquency stage to liquidate with a loss, assuming the roll rate matrix remains constant and that cured loans do not re-default. If we define the roll rate matrix, R, as the first four columns of the transition matrix above and the liquidation rates, L, as the final column, then the implied probability of liquidation, D, and months to liquidation, M, can be calculated as:

$$D_i = L_i + \sum_j R_{ij} D_j \qquad D_i M_i = L_i \cdot 1 + \sum_j R_{ij} D_j (M_j + 1)$$

If we define the weighted months to liquidation, W, as:

$$W_i = D_i M_i$$

then the equations can be re-written using matrix operations:

$$D = RD + L \qquad W = L + RD + RW$$

and solved as:

$$D = (I - R)^{-1} L \qquad W = (I - R)^{-2} L$$

where I is the identity matrix. The implied probability of and time to liquidation using this method is shown in Figures 25.7 and 25.8.

It is clear from Figure 25.7 that the time to liquidation for seriously (60+ days) delinquent loans increased slightly during the recession but has been mostly constant at about 20 months ever since. From foreclosure (and especially bankruptcy), the time to liquidation has increased, but this has been offset by the increasing presence of short sales which circumvent the normal delinquency progression (resulting in the flat time-to-liquidation for seriously delinquent loans). While the time-to-liquidate has changed little since 2008, the probability of liquidation has decreased substantially for seriously delinquent loans (from 35% down to 15%). This is, no doubt, a reflection of the waves of

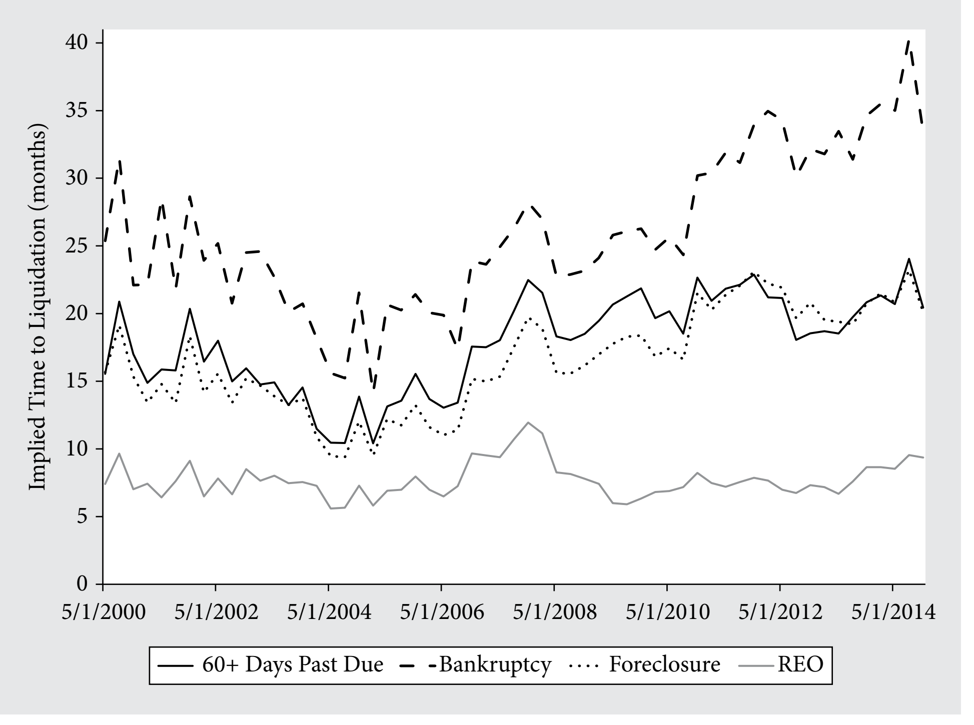

FIGURE 25.7 Time to liquidation-with-loss implied by observed monthly roll rates for non-agency, first-lien securitized loans by stage of delinquency

modification that took place starting in 2009. The foreclosure and bankruptcy liquidation probabilities also dropped, indicating that many of these loans were able to obtain modifications as well. Since house prices started recovering in 2012, liquidation rates have dropped further.

These considerations are important for modelers of mortgage default since many rely on timelines to model post-default behavior. Other models, based directly on roll rates, do not require the measurement of liquidation timelines. However, in a rapidly changing environment, being able to monitor and explain the operation of the mortgage industry is crucial nonetheless.

How Models Can Keep Up with a Changing Industry

The extent and importance of the transformations that took place in the mortgage industry following the credit crisis emphasize why prepayment and default models must be developed with an open structure that allows for assumptions to be made in an unambiguous way. When model sensitivities are parameterized using unintelligible sets of coefficients, they become difficult to modify. Instead, the model's assumptions about how the industry will operate should be placed in a transparent framework that allows

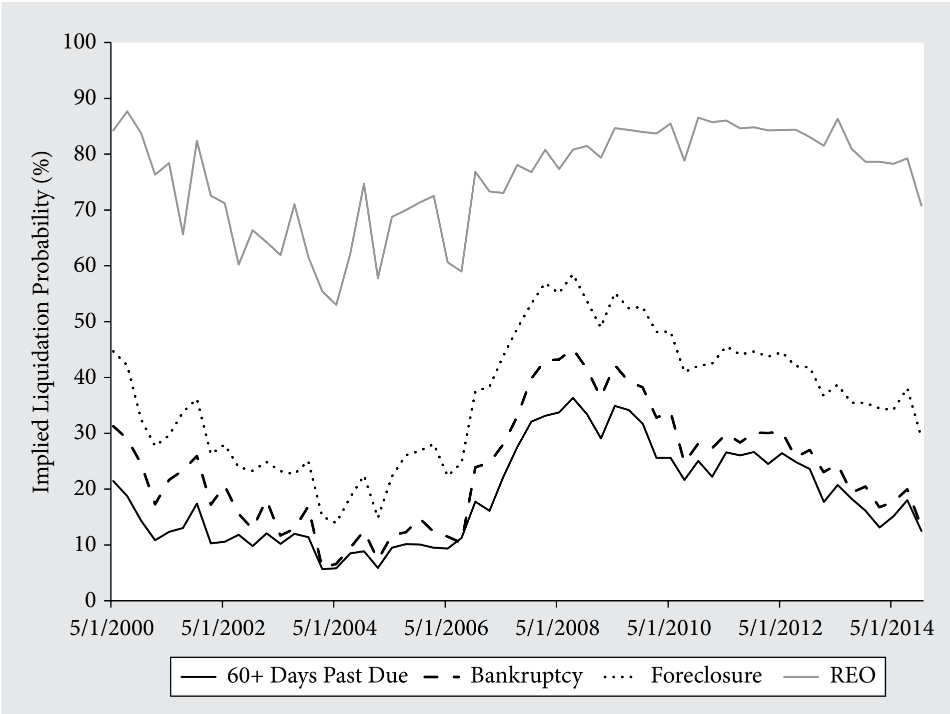

FIGURE 25.8 Probability of liquidation-with-loss implied by observed monthly roll rates for non-agency, first-lien securitized loans by stage of delinquency

for suppositions to be properly modeled. Given current questions surrounding GSE reform and the potential for the return of private-label securitization, models must support a wide variety of these types of ad hoc scenarios.

Uncertainty and Burnout

A pool of mortgages generally contains a variety of loans, each one having somewhat different characteristics from each other. This means that the loans prepay and default at different rates. Over time, the faster-terminating loans tend to leave the pool first. This causes the composition of the pool to change with exposure to termination and it implies that, all else being equal, the rate of termination tends to slow over time. This effect is commonly known as burnout.

However, burnout occurs even for a single loan. Regardless of how complete a given loan data set may be, there are always uncertainties about each borrower that affect how they will prepay or default. Over time, these hidden variables manifest themselves by causing the loan to either prepay or not. Simply by remaining alive, formerly unknown information about the loan is revealed. Just as a pool exhibits burnout due to its distribution of loans, a loan will burn out because of those borrower uncertainties. In this way, a loan's prepayment and default rates depend not just on its initial characteristics, but also on the economic path traversed by the loans. The burnout that arises from this effect is one of the most challenging components of prepayment and default modeling because it involves ascertaining the existence of hidden variables or uncertainties (which are not directly observable) solely from the effect that their burnout has on prepayment and default.

Burnout can be described quantitatively in the following way—given a distribution of loans (or equivalently, a distribution of possible loan attributes), suppose that the *i*th component of the distribution has a population density and rate of termination (including both prepayments and defaults and compounded continuously) given by N_i and P_i, respectively. Then, the average termination rate is calculated as:

$$\bar{P} = \frac{\sum_i P_i N_i}{\sum_i N_i}$$

Since the population density changes with time as:

$$\frac{dN_i}{dt} = -P_i N_i$$

then the average termination rate evolves with time according to:

$$\frac{d\bar{P}}{dt} = \frac{\sum_i \frac{dP_i}{dt} N_i}{\sum_i N_i} - \frac{\sum_i P_i^2 N_i}{\sum_i N_i} + \left(\frac{\sum_i P_i N_i}{\sum_i N_i} \right)^2$$

which can be written more succinctly as:

$$\frac{d\bar{P}}{dt} = \overline{\left(\frac{dP}{dt} \right)} - \sigma_P{}^2$$

where σ_P is the standard deviation of *P* across the distribution. The first term on the right side of the equation is simply the average change in termination speed while the second term, a measure of the variation in termination rates across the distribution, accounts for burnout. Conceptually, any factors which cause speeds to increase or decrease across the board, such as incentive changes, will affect the first term. But, in addition to those factors, the average speed will also tend to decrease over time because the faster paying components leave the pool more quickly. This deceleration is determined solely by the variance of termination speeds. Burnout will cease if all of the components of the distribution terminate at the same rate, and will be enhanced whenever the components diverge.

Uncertain Variables

There are three main uncertain variables that play the greatest role in driving mortgage behavior. Depending on the economic environment, burnout with respect to each can become important. The break-even incentive that would cause a borrower to refinance, the property's mark-to-market value, and the borrower's credit profile serve as these generalized uncertain variables and examples of their burnout are described in the remainder of the section.

The most obvious manifestation of burnout, and the one most described in the literature, relates to the break-even incentive that would induce a borrower to refinance. Conceptually, an eligible borrower will refinance when their interest rate savings over the expected life of the new loan exceed the (one-time) cost to refinance, but, in practice, there is a wide variation among borrowers owing to their differing expectations of how long they will remain in the house, how inclined they are to spend time investigating a new mortgage, and whether any changes in their personal life would affect the mortgage rate they could obtain. Empirically, the refinance break-even is observed to range from as low as 25 basis points up to several percent. Given this variation among borrowers, a newly originated pool exposed to an incentive will typically prepay vigorously for several months as the low break-even borrowers refinance. After those borrowers have prepaid, the pool becomes dominated by high break-even refinancers that choose to hold off on refinancing and the prepayment speed slows.

This effect is illustrated in Figure 25.9 which shows prepayment speed, prepayment factor (the percentage of borrowers not yet prepaid), and incentive for a large

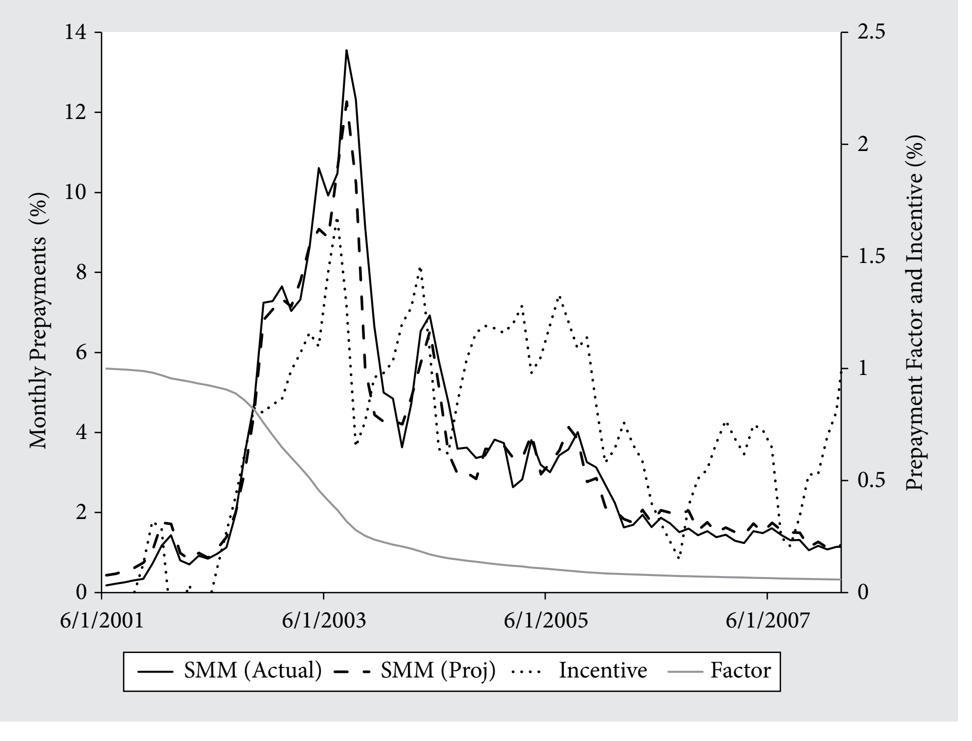

FIGURE 25.9 Model and historical prepayment rates, incentive, and prepayment factor for 2001-originated, 7% gross coupon GSE-backed 30-year fixed mortgages

2001-originated cohort. When the incentive rose to 80 basis points in late 2002, prepayment speeds jumped to over 7%/month. By 2003, the incentive had risen to 170 basis points and speeds topped out around 13%/month. However, by 2005, only (the slowest-prepaying) 12% of the cohort remained and prepayments speeds were flat around 3.5%/month despite the fact that those loans still had an incentive of 120 basis points. At this point, the cohort can be said to be burnt out.

It is worth reiterating that in this example, some of the cohort's burnout is caused by the variation in prepayment propensity across loans. This portion is observable and can be measured by the changing composition of the pool of loans. A loan-level model, one that forecasts a different prepayment rate for each loan, will naturally contain this burnout simply by averaging its projections across the loans weighted by their expected balance. However, some burnout is caused by the intrinsic uncertainty of a specific borrower's break-even incentive. This portion of the burnout must be modeled directly.

Another critically important and uncertain attribute is the value of the property backing the loan (or equivalently, the LTV). Depending on the geographic granularity of the data source, more or less precise house price appreciation rates may drive changes to the LTV; however, improvements, deterioration, and other factors specific to the property will always create some uncertainty in its mark-to-market value. Direct real estate sale data corroborate that, for a given loan, the uncertainty in property value is no less than about 15%, even when using the most granular house price indices.

This uncertainty is manifested most obviously in the loss severities which occurred during the bubble years of 2004–6. Since LTVs were low and declining during this interval, there were few defaults. However, those loans which were liquidated exhibited eventual sale prices much lower than would be suggested by their house price index. This effect is illustrated in Figure 25.10 which shows the distribution of (uncertain) current LTV for a typical bubble-era default. In this example, HPI indexing of the original LTV would suggest a current LTV of 85%. When a mortgage's LTV is under 100%, the borrower is able to sell the house to pay off the mortgage. However, because the current LTV is uncertain, there is some probability that the actual LTV is greater than 100% which may lead to liquidation and investor loss. For the distribution shown in this example, the average current LTV of the loan given liquidation ends up being 108%. This is important because realized loss severities will reflect these higher LTVs. In this case, a failure to consider property value uncertainty would result in an underestimation of losses.

In fact, this mechanism can be observed and was significant in driving up loss severities during the bubble-era. In Figure 25.11, actual loss severities on defaulted loans are compared against a simple accounting of the loss components. The accounted loss severity is constructed to include the lost unpaid balance, carried interest from the loan's time in delinquency, and fixed costs of $40,000 which represent foreclosure costs, property maintenance, and sale costs. The recovered property sale price is estimated as the original property value (derived from original LTV and loan amount) indexed by HPI to the date of sale, then decreased by 25% to reflect the distressed nature of the sale. As evidenced by Figure 25.11, this simple model performs well for severities higher than

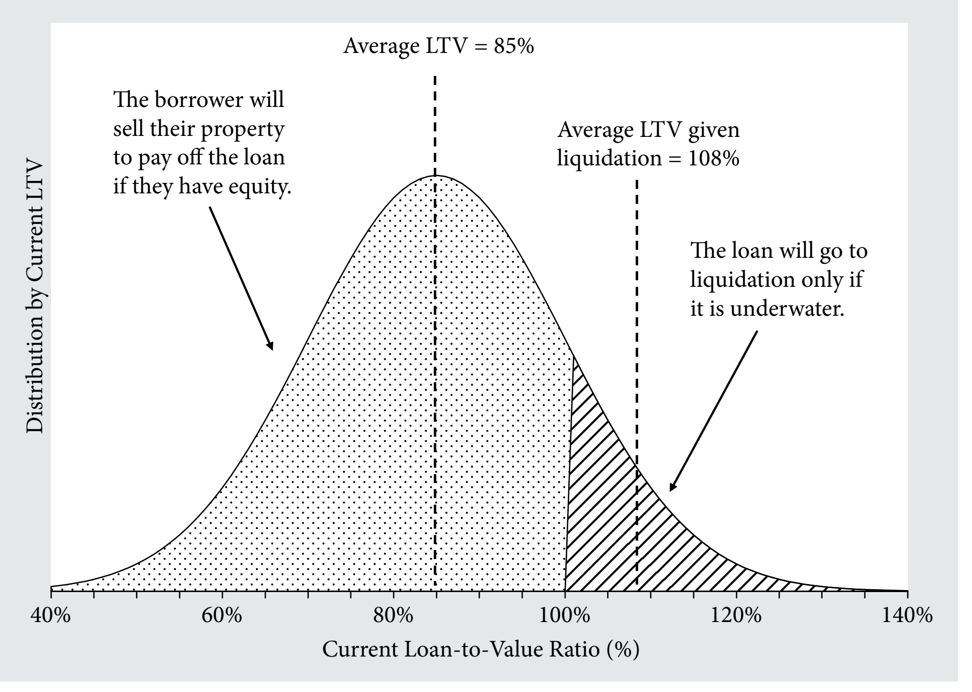

FIGURE 25.10 Defaulted loan example (HPI-indexed LTV of 85% with uncertainty of 15%)

Note: Illustration of the distribution of current loan-to-value ratio for a typical bubble-era default. In this case, current LTV is estimated at 85%, but is uncertain and has a standard deviation of 15%. Liquidation (in which a loss is taken) will occur only if the loan occupies the portion of the distribution with LTV higher than 100%. As a result, the average LTV given liquidation will be about 108%, much higher than the distribution's mean of 85%.

about 50%, but under-projects losses below that threshold because the indexed LTV does not account for the effect illustrated in Figure 25.10. As the indexed LTV declines below 100%, the LTV of liquidated loans remains above 100% and the actual loss severity is floored at a level determined by the carried interest and fixed costs. By comparison, a good fit across all severities can be obtained by correcting for LTV uncertainty. The dashed line in Figure 25.11 shows the result of increasing the liquidation LTV according to the mechanism described above.

The third major borrower uncertainty has to do with a borrower's credit profile. While updated credit scores can be obtained in some cases, these scores do not reflect changes in job status or income, nor are they definitive about whether a borrower would qualify for new mortgage financing. When a default occurs, the missed payments generally precede the decline in credit score. As a result, the borrower credit needs to be treated as an uncertain variable and this leads to several forms of burnout. The term "credit burnout" refers to how a pool's average credit tends to improve (and default rates slow) when exposed to a stressful economic environment as the least creditworthy borrowers default and leave the pool. This effect helps explain why industry-wide default rates peaked in 2009 even though house prices continued to decline until 2012. Credit also affects mortgage eligibility. In the post-crisis period, underwriting standards were tightened

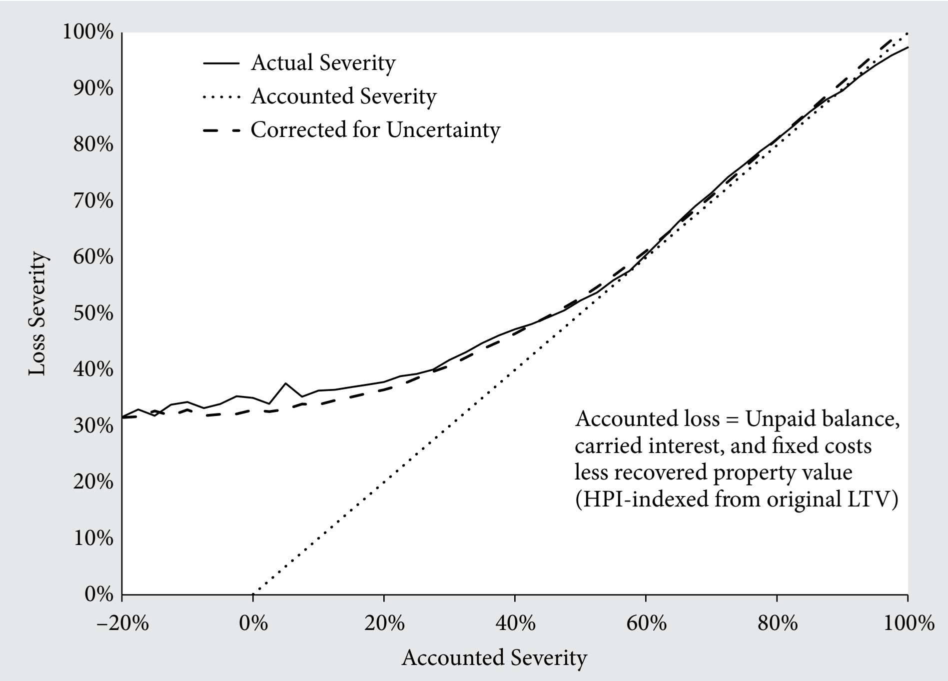

FIGURE 25.11 Loss severity vs simple accounting of loss (non-agency universe)

Note: Average actual loss severity for the non-agency first-lien universe, grouped according to a simple accounting of loss components which includes the unpaid balance, carried interest, \$40,000 of fixed costs, and a recovery of 75% of the HPI-indexed property value (based on the original LTV)

and a significant fraction of borrowers were locked out of refinancing. Figure 25.12 illustrates an example where this lock-out leads to additional burnout. Like the 2001-originated cohort shown in Figure 25.9, a large 2008-originated cohort is steadily exposed to increasing incentives. Because a sizable portion of the borrowers are locked out, the prepayment speeds never reach as high as the 2001 originations. However, despite the slow prepayment, the pool still burns out relatively quickly. By late 2011, a new high point for incentive is reached, but speeds remain slower than they were in 2010, even though only half of the pool had prepaid. In comparison with the pre-crisis period, the burnout is occurring almost twice as quickly. Of course, this is exactly what you would expect to see given that the prepayments are concentrated in the relatively small subset of borrowers which have both a low break-even incentive and eligibility to refinance.

Since credit affects both mortgage eligibility and affordability-based default, the potential exists for burnout from one to affect the other. Figure 25.13 provides evidence of such an effect. Shown are default rates and prepayment factors for the 2000 and 2003 vintages of GSE 30-year fixed collateral. Both vintages shared a similar credit profile, both experienced uninterrupted house price appreciation, and both exhibited initial default rates under 0.1% per month. However, the 2000 vintage saw declining mortgage rates and refinanced vigorously. By the end of 2003, only about 7% of the loans remained

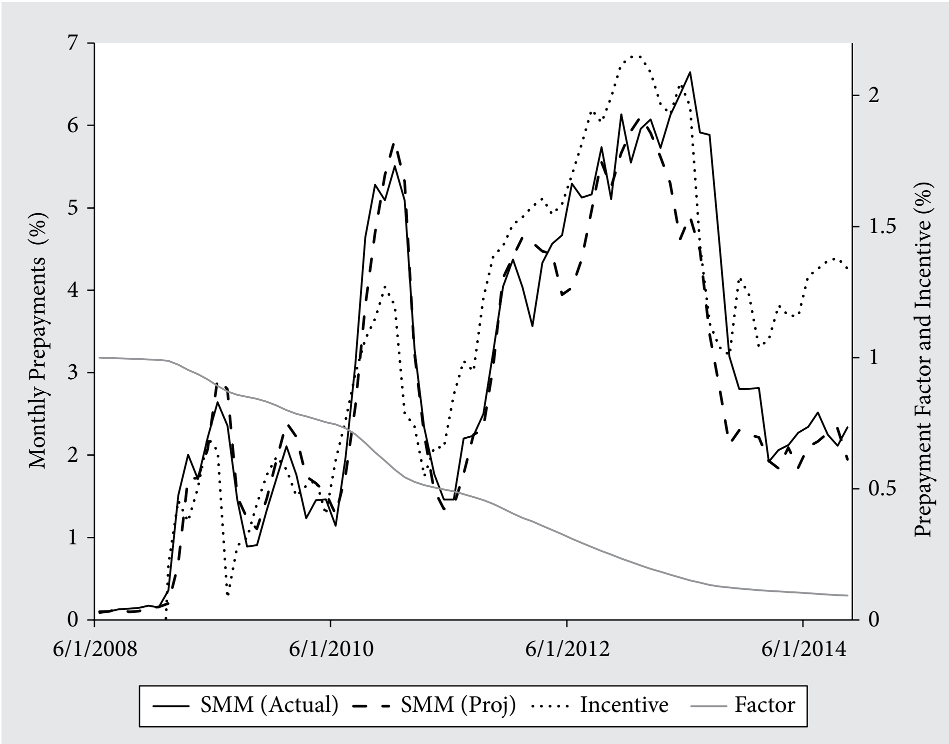

FIGURE 25.12 Model and historical prepayment rates, incentive, and factor for 2008-originated, 5.5% gross coupon GSE-backed 30-year fixed mortgages

active. The cohort was thoroughly burned out, by that point composed primarily of borrowers that were locked out due to poor credit. In the following years, the 2000 vintage saw default rates almost an order of magnitude higher than those of the 2003 vintage.

Less Granular Data Sets

In addition to the three main loan-level undetermined attributes discussed in the previous section, the concept of uncertainty is useful in modeling securities for which only aggregate or less granular data is available. In this case, a loan-level model may be used if the less granular field or distribution across loans can be approximated by increasing the uncertainties of the undetermined attributes. For instance, if a loan is missing an initial credit score, the uncertainty in the credit attribute can simply be increased. If only state-level geography is known, the standard deviation of HPIs across ZIP codes can be measured and included in the LTV uncertainty. For an aggregate security, like a FNMA TBA, in which only the weighted-average coupon is known, then incentive break-even distribution can be widened. For each of these cases, burnout will be appropriately strengthened.

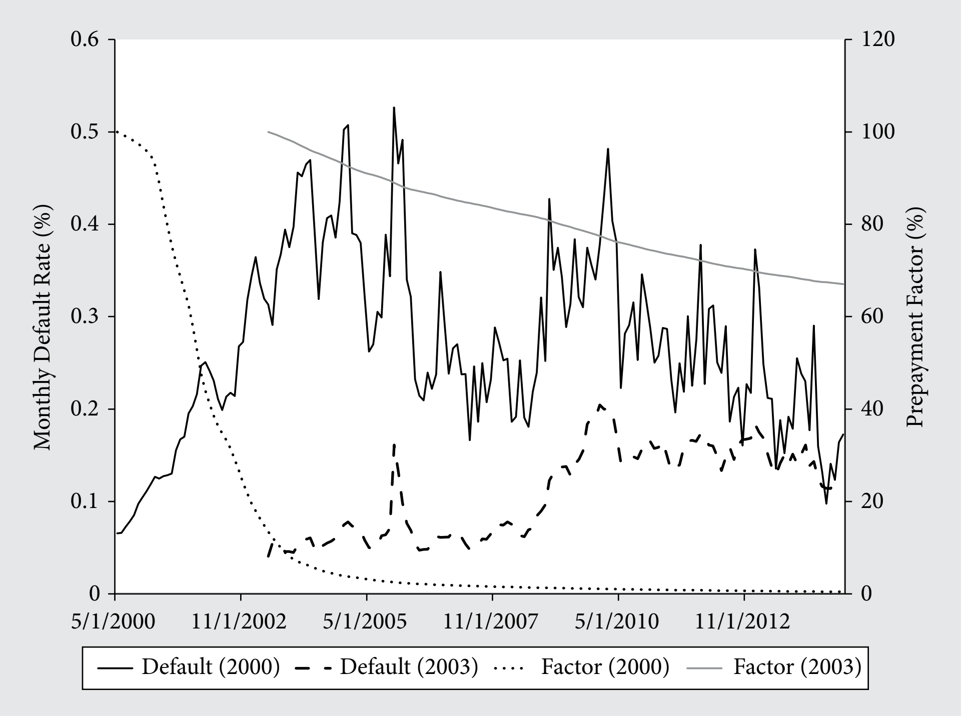

FIGURE 25.13 Historical default rates and prepayment factors for 2000- and 2003-originated, GSE-backed 30-year fixed mortgages

Multidimensional Burnout

Modelers employ a number of methods to account for these various types of burnout. The simplest approach makes use of exposure variables to track the accumulation of some factor responsible for the burnout. For example, incentive, summed over the life of a mortgage, might be used to approximate how many of the remaining borrowers have a tight incentive break-even. In this way, higher exposure would drive a dampened refinancing response. While exposure variables may suffice as first-order burnout approximations, this technique has two main drawbacks. First, it is duplicative because, in order to properly measure the composition changes, the exposure variable needs to contain most of the sensitivities which drive the termination itself. More fundamentally, it attempts to represent the uncertain variable's composition through a single factor, therefore it has no way to account for how the shape of the distribution evolves in a more granular way.

Multi-population models offer a better alternative. By approximating an uncertain attribute's distribution as a discrete set of populations, more information about its shape is preserved. To account for refinancing burnout, for example, the populations might represent loans grouped according to their incentive break-even. In this way, the entire history of which incentives were experienced can be recorded in the population breakdown. However, the multi-population approach becomes inefficient for modeling the multidimensional distribution across several uncertain variables. When this distribution is not separable, the number of populations can become very large and computation time a problem.

The most general but also most computationally challenging option involves the use of Monte Carlo simulations to generate, for each loan, a set of equally likely random paths for the uncertain variables. These paths can approximate the combined variables' distribution arbitrarily well and the approach allows a model to depend not only on their outstanding values, but also on their paths taken. Since the paths will have differing survivals, burnout will be reflected organically in the aggregate output.

Valuation Techniques

An MBS is a callable bond with a complex option structure that is exercised inefficiently and in a path-dependent way. Like any bond, its value is determined by its future cash flows which themselves depend on the mortgages' prepayment and default rates. Using a mortgage model, monthly projections of those rates can be associated with a specified economic scenario, thus allowing an MBS to be valued.

Static scenarios, consisting of shocked interest rate flat or forward curves and constant-growth or mean-reverting house price paths, are frequently used to evaluate MBS yields. This technique allows the realism of the model projections to be assessed in a specified economic environment and provides some baseline estimates of the mortgage-backed security's potential returns. However, given the simplicity of the static scenarios and the complexity of the bond's optionality, this method often fails to provide a good characterization of the distribution of possible MBS yields.

As an alternative, option-adjusted calculations simulate a set of economic paths which better span the space of possible future environments. Historically, only interest rates were modelled as a random variable and much study has gone into creating interest rate processes to generate potential rate paths which are consistent with the observed term structure of yields and volatilities. However, the option-adjusted technique is equally applicable to house prices and other important variables in the economic environment, including those that drive credit risk and those which characterize the functioning of the mortgage industry. By including these drivers in the Monte Carlo simulation, the mortgage-backed security's return can be evaluated across a wider range of environments. Using a mortgage model, the cash flows of the MBS can be calculated for each of the scenarios, providing an estimate of the bond's risk as well as a measure of expected return, the option-adjusted spread. Duration and convexity, essentially first and second derivatives of value with respect to parallel interest rate moves, can be calculated by repeating the option-adjusted calculation at higher and lower interest rates.

In practice, option-adjusted valuation is widely used to quantify interest rate risk, which can be hedged using available liquid interest rate derivatives. More recently, these techniques are being adopted to characterize credit risk as well; however, corresponding hedges for factors like house price appreciation are generally nonexistent or illiquid. Finally, it should be noted that mark-to-market prices do not necessarily respond to collateral characteristics and interest rate movements in the same way as model option-adjusted valuations. Thus, for short-term positions and hedging, it is necessary to calibrate a prepayment and default model to market prices, even at the expense of model accuracy. To the extent that the "market-implied" model diverges significantly from what one may consider reasonable, it may be an indication of market mispricing, and hence an arbitrage opportunity.

Key Points

- MBS value is determined by the prepayment and default options embedded in a mortgage.
- A model quantitatively relates the exercise of prepayment and default options to the economic environment.
- An accurate model, with interest rate hedges, can unlock arbitrage opportunities.
- A model's full utilization of loan-level data can differentiate otherwise similar MBS.
- Traditional regression models are not optimized for long-term out-of-sample prediction of prepayment and default rates.
- Borrower behavior regarding housing turnover, refinance, and default is intuitive and a properly structured model reflects this.
- The mortgage industry has undergone many significant changes in the wake of the credit crisis which affect borrowers' eligibility and how defaults are processed.
- Unavoidable uncertainties in property value, borrower credit, and desire to refinance lead to burnout.
- An accurate representation of burnout, which today is occurring across multiple dimensions, is imperative for long-term prepayment and default model accuracy.
- An option-adjusted framework, which samples many possible future economic environments, will better characterize the distribution of potential MBS cash flows.

CHAPTER 26

CONTEMPORARY CHALLENGES IN LOAN-LEVEL PREPAYMENT MODELING

STEVE BANERJEE, ANAND BHATTACHARYA, AND BILL BERLINER

AFTER reading this chapter you will understand:

- how parameters observed at loan level are better at predicting prepayment speed in contrast to those observed at pool level;
- the impact of variables such as loan size and credit score on the observed prepayment speed;
- how delinquencies and defaults influence prepayment speed;
- how the impact of the financial crisis complicates prepayment modeling and how to properly censor data that may be biased due to government intervention programs;
- how to build robust prepayment models appropriate for the post-financial-crisis period.

The use of prepayment forecasts is an important and critical component of any form of mortgage-backed securities (MBS) valuation. As such, the development of underlying models for prepayment predictions is a heavily researched and debated topic in MBS forums. Over the years, the quantification of prepayments has moved from reliance on point estimates to the adoption of complicated mathematical and statistical models. Along with the growth in sophistication of forecasting technology, the prepayment modeling effort has also incorporated expanded data sets that detail extended obligor and property characteristics. Historically, the traditional prepayment-forecasting paradigm has relied heavily on macro-level parameters, such as interest rates and demographics. However, recent efforts have increasingly focused on loan-level parameters that are considered relevant in forecasting the propensity of the borrower to exercise the prepayment option. As such, prepayment forecasts are differentiated along the nomenclature of "pool" versus "loan" level.

The fact that prepayment modeling efforts have gravitated toward the usage of granular data is perhaps a reflection of the trend of a growing lack of homogeneity in the origination of mortgage loans. Due to the advent of risk-based pricing, which relies on the relative importance of obligor and property parameters, recently originated mortgages have varying elements of heterogeneity. As a result, the prepayment response function changes as a function of the characteristics of the underlying loans. At the same time, such efforts have been made possible by the increasing availability of loan-level data from government-sponsored agencies.

While availability of loan-level information is a very important step in building robust prepayment models, the process has become ever more challenging since the financial crisis of 2008. Almost all the metrics and their co-relationship that were used to forecast prepayments prior to the crisis went through a severe metamorphosis. This is particularly true of the period between early 2009 and late 2011. An unprecedented degree of government intervention in the mortgage market, along with the cascading effect of plunging (later followed by recovering) home prices, changed the prior observed relationships between prepayment speeds and parameters such as economic incentive for refinance, credit score, loan-to-value ratio, and geographical location.

Prepayment modeling has always been an exercise where statistical elegance and purity takes a back seat to the modeler's experience and intuition. The financial crisis of 2008 has skewed the balance even more toward experience and ingenuity that is almost impossible to replicate through statistical models alone.

In this chapter we evaluate the relative importance of various loan attributes with respect to prepayment propensity, focusing special attention on the post-financial-crisis period. This is followed by a detailed discussion of the impact of the financial crisis on prepayment analysis. One aspect of the tables and figures presented here needs prior explanation. The tables and figures often refer to HARP (Home Affordable Refinance Program) ineligible loans. HARP has a cut-off date of May 31, 2009, so HARP ineligibility means loans that were originated soon after this cut-off date.

Minimizing Loan Dispersion

The primary benefit emerging from the focus on loan-level analysis is the mitigation of problems arising from data dispersion, which occurs due to inherent differences in loans. In loan-level analysis, the parametric characteristic of each and every loan is considered, eliminating the possibility of not incorporating the effects of particular attributes. While mortgage pools may have similar average loan parameter values, their prepayments could be quite different due to dispersion in loan characteristics.

This is demonstrated in Table 26.1, where prepayment observations from three pools of 30-year loans are considered. The loans were originated in 1998, 1999, and 2000 and the actual prepayment observation was recorded during the period January 2001 through April 2001. During this period, the bulk of these loans were moderately refinanceable. This characteristic provides the opportunity to observe the effect of coupon dispersion

Table 26.1 Prepayment speed comparison of pools with similar average loan parameters but different note rate distributions

	Pool 1	Pool 2	Pool 3
Number of loans in pool	48,637	12,970	10,704
Weighted-average note rate	7.50%	7.47%	7.44%
Age (months)	25	26	26
Average loan size	$299,000	$293,000	$294,000
Standard deviation of note rates	50 bps	10 bps	6 bps
Skew-ness of note rates	0.93	0.42	–0.18
CPR	21.0%	16.4%	14.9%

Note: Prepayment observations recorded in the period January 2001 through April 2001

Source: FNMA, Performance Trust Capital Partners, LLC

on prepayment speeds as this effect gets magnified for loans that are moderately in the money.[1] All three pools have a similar weighted-average coupon (WAC), loan size, and age. However, the WAC distribution in Pool 1 is highly skewed toward higher note rates (standard deviation of 50 basis points and skewness of 0.93). In contrast, the WAC variation in Pool 2 is subject to less dispersion and skewness (standard deviation of 10 basis points and skewness of 0.42). Pool 3 is even more symmetrically distributed in terms of WAC than Pool 2, with standard deviation of 6 basis points and skewness of –0.18.

Table 26.1 displays the average prepayment speeds of these pools. In the period of observation, Pool 1 recorded average speeds of 21.0% conditional prepayment rate (CPR), Pool 2 displayed a rate 16.4% CPR, while Pool 3 paid down at 14.9% CPR. Pool 1, which had the largest bias toward higher-coupon loans, prepaid at the highest rate, while Pool 3, which was the most symmetrically distributed, prepaid at the lowest rate.

It is reasonable to conclude from the observations above that seemingly similar pools can lead to different prepayment profiles based upon the distribution of the loan attributes, which can arise due to inherent differences in characteristics. This in essence is the *raison d'etre* for the inclusion of loan-level parameters in prepayment forecasting.

The Full Picture

In addition to the effect of WAC dispersion on prepayments noted in the previous section, deviation of other loan parameters could also have a significant effect on prepayments. These parameters along with the associated potential effects of these attributes are described below.

[1] The inclusion of more recent data would not have allowed this effect to be captured completely. In later years, particularly during the refinancing wave of 2001–3, such loans would have been deeper in the money, resulting in the interest rate effect dominating the effects of more convex property and obligor variables.

- **Loan-to-value ratio:** A loan-to-value (LTV) ratio higher than acceptable levels (typically greater than 80%) usually acts as an impediment to prepayments. A related element in this domain is home price appreciation, which generally leads to lower LTVs. As such, loans in areas with significant real estate growth are expected to prepay faster. Therefore, in addition to the actual magnitude of appreciation, the geographic location of the underlying property is also a factor in assessing prepayments.
- **FICO scores:** Borrowers with superior credit profiles, as reflected by FICO scores, are exposed to an expanded refinancing opportunity set. Therefore, in the absence of any property-related impediments (e.g., high LTV), prepayments associated with such loans are expected to be faster.
- **Loan size:** As loan size increases, the prepayment behavior of the underlying loans is expected to be faster.
- **Lien status:** For properties with first and second liens, the prepayment patterns are interlinked and determined by the level of the combined LTV.
- **Private mortgage insurance:** The prepayment pattern of high LTV loans with private mortgage insurance (PMI) is usually motivated by the desire to remove the non-tax-deductible PMI payment after the underlying property has appreciated in value.
- **Documentation:** Loans with full documentation attributes are likely to prepay faster than those with reduced documentation, primarily because the latter face more barriers to refinancing.
- **Occupancy status:** In the absence of significant real estate appreciation, loans that are used to finance investment properties are likely to exhibit slower prepayments than owner-occupied properties, mainly because investment loans are more expensive and hence have a higher refinancing threshold.

The preceding discussion has described the effect on prepayments of the more common loan attributes. In other situations, prepayments can be slower because of structural impediments such as refinance taxes, which are levied in New York, for example. Note that the discussion of the effects of loan parameters above has focused on the associated effects in isolation and not taken into account the multiplicative effects of such factors. For instance, prepayments are likely to be faster for higher FICO and lower LTV loans than for similar FICO and higher LTV loans. It is also possible that for certain loans, the effects of certain parameters (low LTV) that lead to faster prepayments may be counterbalanced or, perhaps, offset entirely by the dampening effects of other parameters (such as a low FICO score).[2] A detailed evaluation of the effects of loan-level parameters is provided in the following sections.

[2] Such loans may still exhibit faster prepayment behavior in the event the obligor can obtain refinancing through an alternative mortgage program.

Loan-to-value ratio (LTV)

A decline in the level of the LTV affects the ability of mortgagors to advantageously engage in refinancing, with or without cash-out. Additionally, any decline in the LTV, particularly for marginally higher LTV loans (for example, loans with original LTV ratio just above 80%), may lead to the obligor obtaining preferential financing at a lower rate. By the same token, higher LTV loans may not be able to obtain sufficiently economical rates to trigger prepayment of the loan.

LTVs decline due to the accumulation of equity. Equity in homes may increase as a result of amortization of principal or more dramatically due to real estate appreciation. Conversely, homeowners' equity may register declines due to negative amortization or the devaluation of real estate, leading to an increase in the LTV ratio.

Home Price Appreciation

As noted above, improvements in LTV can occur as principal is paid down or when the underlying property experiences appreciation. With respect to prepayment speeds, real estate appreciation produces a combination of the following effects.

- **LTV meets underwriting criteria:** As a result of accumulation of equity in the property, the borrower is able to qualify for preferential refinance rates offered by lenders.
- **Cash-out refinancing:** Due to the accumulation of equity in the property, obligors may choose to liquefy some or all of the equity for various personal expenditures.
- **Trade-up buying:** The equity build-up may be used to trade up to more expensive homes.
- **Consolidation of first and second mortgages:** As the underlying property appreciates in value, obligors may use the increased equity to consolidate more expensive second mortgages into a new first mortgage at a lower LTV.
- **Cancellation of mortgage insurance:** Generally, mortgage insurance is required for loans with LTVs greater than 80%. Under the provisions of the Homeowners Protection Act of 1998, lenders are required to automatically cancel mortgage insurance when the mortgage balance reaches 78% of the original value of the home, without taking into effect the impact of prepayments. However, once the LTV ratio falls below 80% due to increased home valuation and/or loan amortization, the borrower can request a revaluation and subsequent mortgage insurance cancellation. Alternatively, obligors may choose to effectively cancel this insurance by refinancing at lower LTVs. More often than not, refinance is the preferred route as the borrower may also be able take cash out during the process. As such, the existence of private mortgage insurance has been labeled as one of the "silent" drivers of prepayments.

Conversely, declining home values drive up the LTV ratio, making refinance difficult. In extreme situations the updated LTV may reach or exceed 100%, prompting some borrowers to default on their payments as they may not have the desire to hold onto a property that is worth less than what is owed on the property. Such action will lead to so-called involuntary prepayments. Involuntary prepayments can occur due to servicers buying defaulted loans out of pools or liquidation of such loans during a foreclosure proceeding.

Figure 26.1 shows the impact of home price appreciation (HPA) through changes in updated LTV on FHLMC 30-year conforming loan prepayment speeds, controlling for the economic incentive to refinance. It is clear from this exhibit that loans with updated LTV below 80% prepay at a faster speed compared to loans whose ratios are between 90% and 100%. Even when the economic incentive to refinance is very limited, the lower updated LTV loans prepay somewhat faster. This could be due to cash out refinance opportunities and also increasing home sales in a rising real estate market.

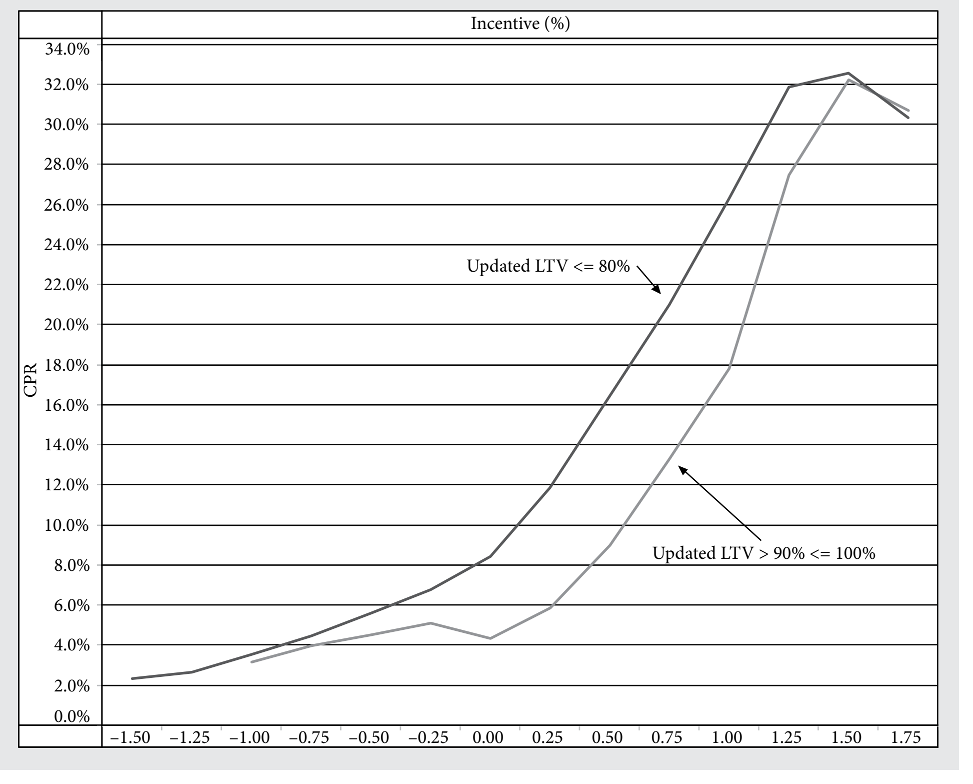

FIGURE 26.1 Impact of HPA: FHLMC 30-year conforming, HARP-ineligible S-curve by updated LTV (1/2013 to 1/2015 reporting period)

FICO Scores

Credit scores, which are provided by credit reporting agencies such as Experian, Equifax, and TransUnion, are widely utilized in the mortgage underwriting process. Each one of these companies provides a score, which is based upon the individual's past credit history and current and potential indebtedness, with most scores falling between 550 and 800. Experian provides the FICO score, Equifax uses the Beacon score, and TransUnion computes the Emperica score. However, in industry parlance, the FICO score is generically used to describe credit scores, irrespective of which credit agency is providing the score.

Figure 26.2 shows the effect of FICO scores on conforming loans as a function of refinance incentive. Borrowers with high FICO scores are exposed to an expanded mortgage financing opportunity set while borrowers with lower scores generally pay a combination of higher rates and fees. As depicted in the figure, loans to obligors with lower FICO scores exhibit slower speed. The effect of FICO scores on prepayments is not necessarily uniform. For instance, an improvement in credit scores for higher FICO

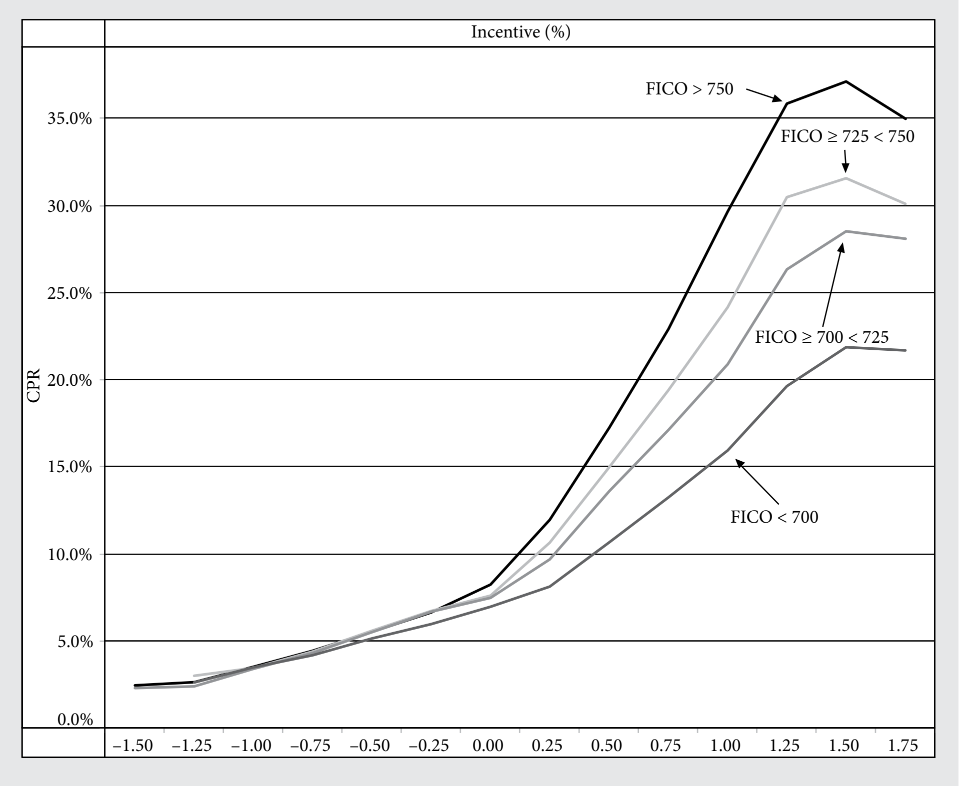

FIGURE 26.2 Impact of FICO score: FHLMC 30-year conforming, HARP-ineligible S-curve (1/2013 to 1/2015 reporting period)

borrowers may not lead to an appreciable increase in speeds. However, for lower credit borrowers, improvement in FICO scores may lead to significantly faster prepayment as such borrowers use the improved credit status to refinance or "credit cure" into lower-rate loans.

Combined Impact of LTV and Credit Score

As stated earlier, the combined impact of LTV and credit score is a very important determinant of prepayment speed, particularly since the financial crisis. Underwriting is easier when a borrower has a low LTV ratio along with high credit score. Borrowers with low LTV but poor credit will have difficulty getting approved for refinance. Obviously, this will result in slower prepayment speed for obligors with less than stellar credit compared to the higher FICO borrowers. Figure 26.3 shows how FICO scores affect prepayment speeds even when the LTV ratio of the borrower is less than 80%. For instance, at a refinance incentive of around 100 basis points (bps), borrowers with a FICO score of less than 700 prepay at about half the speed as those with FICO above 750. In the contemporary world of mortgage valuation, the layered risk of LTV and FICO is a critical input to any loan-level prepayment model.

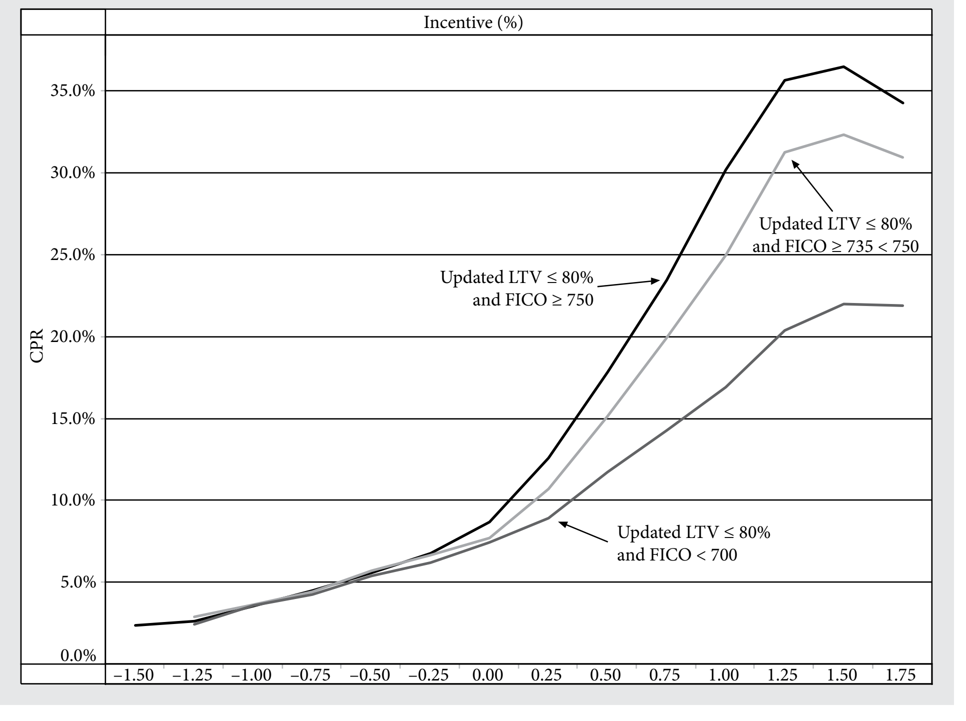

FIGURE 26.3 Impact of updated LTV and FICO: FHLMC 30-year conforming, HARP-ineligible S-curve (1/2013 to 1/2015 reporting period)

Loan Balance

Loans with higher balances are expected to prepay faster than loans with lower balances. The logic here is that loans with higher balances stand to benefit significantly more in a regime of falling interest rates. By the same token, loans with lower balances have a muted response to decrease in interest rates primarily due to the incidence of the fixed costs of refinancing. For loans with low balances, the cash flow economies, adjusted for the upfront costs, may not be realized in the foreseeable future. As a result, there is a vibrant market for MBS that seeks to stratify securities as a function of loan balance, with the explicit objective of exploiting the inherent convexity.[3]

Figure 26.4 depicts the impact of loan balance on the prepayment patterns of conforming collateral at various refinance incentives. The impact of loan balance on speeds is unmistakable. For instance, at around 125 bps refinance incentive, loans with balance below $85,000 prepay about a third slower than loans whose size is between $125,000 and $150,000. At low levels of refinance incentive the differential impact of loan size on

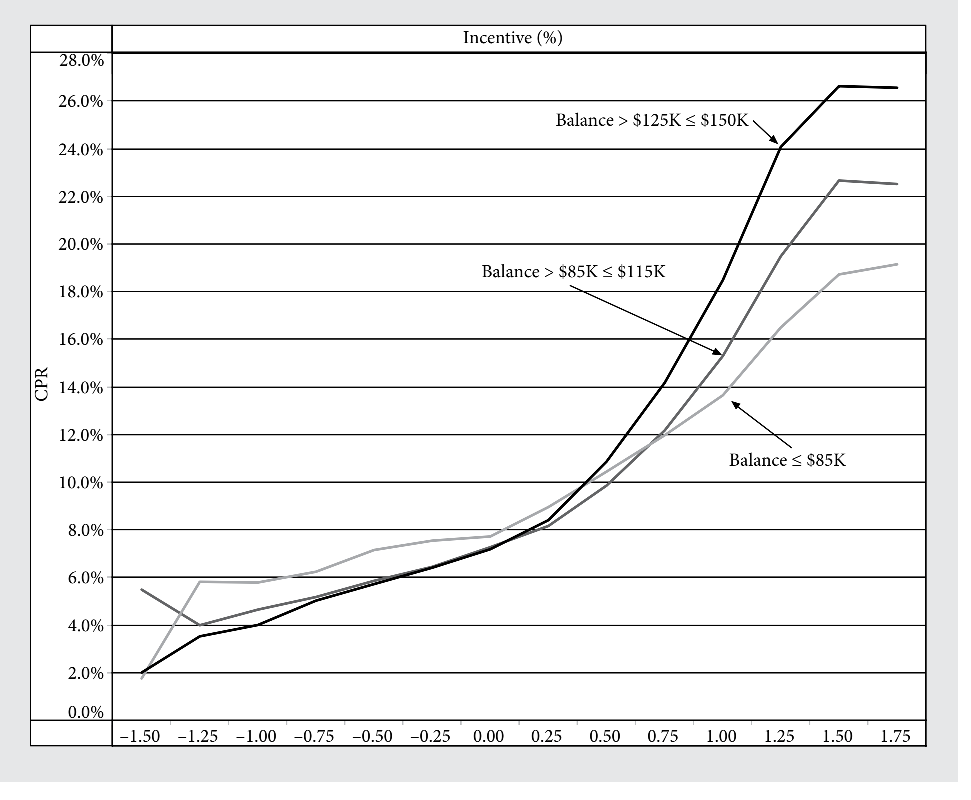

FIGURE 26.4 Impact of loan balance: FHLMC 30-year conforming, HARP-ineligible S-curve (1/2013 to 1/2015 reporting period)

[3] See Chapter 8 for a description and evaluation of such MBS.

prepayment speed diminishes rapidly as the dollar savings resulting from refinance become very small, irrespective of loan balance.

Documentation

The documentation involved in mortgage underwriting seeks to verify, either directly or indirectly, historical credit parameters or the capacity of the obligor to meet loan obligations. This process involves collection and verification of information regarding employment, income, assets, and tax returns. However, some borrowers are either unable or unwilling to provide all relevant documentation. This could be due to uneven income and employment patterns or for privacy reasons.

The effect of documentation type on prepayments is fairly intuitive. A borrower with a reduced documentation loan is somewhat constrained in finding alternative sources of funding. Everything else being the same, reduced documentation loans prepay slower than fully documented loans. Since the financial crisis of 2008, the vast majority of loans underwritten have been of the full documentation type. As a result, documentation as a prepayment parameter only has relevance to the extent it may make a comeback in future loan origination. This would imply some degree of resurrection of the Alternative A and subprime loan products originated during the pre-crisis days.

Occupancy

The occupancy status of the underlying property has a material impact on prepayment speeds. In the period leading to the 2008 crisis, investor loans prepaid faster than owner-occupied loans in a regime of increasing real estate appreciation even when such loans were out of the money. This was due to the fact that investors were motivated in selling the property once they realized a certain level of appreciation.

Alternatively, investors refinanced their loans, taking cash out and raising the LTV to pre-appreciation levels—an event that could occur in the absence of rate incentives. This behavior changed as home prices declined through 2011. As a result, investor loans have generally prepaid slower than regular conforming loans during the period 2009 through 2011. However, with robust home price appreciation since 2011, we started to observe a change in investor prepayment behavior. Investors with very good credit are benefitting from better real estate valuation as more lenders are willing to accept investment properties as loan collateral, leading to pick up in prepayment speed.

Geography

Due to the effect of demographics and interstate migration patterns, the geographical location of the loan often plays a critical role in prepayments. Consequently, prepayment for loans in states where population patterns exhibit a higher degree of mobility are expected to be faster. This is especially true of California, where the combination of a mobile population with a large percentage of recent immigrants and the availability of innovative mortgage products generally results in higher prepayment speeds.

Prior to the financial crisis, the geographical propensity to prepay has often been a function of the mortgage product type. However, since then it has essentially been a function of the real estate market. Before the crisis, California, Arizona, Nevada, and Florida exhibited relatively faster speeds compared to the generic cohort due to rapid home price appreciation. However, during 2009 and 2010 these states were often much slower than the cohort as the rapid drop in home values in these states made it difficult for borrowers to refinance. Since 2011, property values have recovered to a considerable extent though there are significant variations between the states and even within individual states.

Table 26.2 shows prepayment speed by selected states for FNMA 4.00% coupon of 2013 vintage during the three-month period ending in November 2014. During this time the 4.0% coupon was moderately in the money for refinance, and traditional geographic patterns of refinance behavior were re-emerging. California prepayment speed was the fastest at 171% of the cohort speed followed by Massachusetts at 130%. New York, which imposes a mortgage refinancing tax, displayed its well-established slow prepayment rate at 41% and Puerto Rico brought up the rear at 11%. Texas and surrounding areas are generally much slower than the Western states, partly due to the smaller loan balances and somewhat credit-constrained borrowers.

Loan-level models that incorporate regional or state-level prepayment observations are likely to project prepayment more accurately than models that lack such details.

Table 26.2 Geographical prepayment of FNMA 4.0% of 2013* (compared to whole cohort in percentage terms)

California	171%
Massachusetts	130%
Illinois	123%
Colorado	104%
Arizona	91%
Nevada	84%
New Jersey	77%
Texas	66%
New York	41%
Florida	58%
Puerto Rico	11%
Whole Cohort	100%

* Based on three months ending in November 2014

Source: FNMA, Performance Trust Capital Partners, LLC

Lien Status

The lien status of a mortgage can also be fairly important from a prepayment standpoint. Second-lien loan prepayment often tends to be governed by refinance opportunities available to the first-lien mortgage. This is especially true if there is enough built-up equity to wrap the two loans into one single entity. In contrast, a second lien can act as a hindrance to refinancing a first lien as the subordinate lien uses up the critical LTV cushion needed to go through the refinance process.

Spread at Origination

Spread at origination (SATO) is a metric (measured in basis points) that represents a borrower's overall quality compared to the best borrowers who can get the more desirable mortgage rates prevailing in the market. Borrowers who are deficient in credit or LTV ratio will usually be charged an incremental note rate over what gets offered to the best borrowers. This additional note rate expressed in basis points represents SATO. Some high-end borrowers who exceed the standards for what is considered the best category may even have negative SATO. SATO can be highly correlated (positive or negative) with certain parameters like LTV and FICO score.

Mention of SATO is necessary because modelers sometimes use SATO as proxy for parameters that may not be evident in the data, such as uncertain employment situations or wage garnishment orders that will most likely not appear in the available loan-level information. However, one has to be careful when performing regression because of the potential for the existence of strong multi co-linearity between SATO and variables such as FICO that may bias results.

Post-Financial-Crisis Challenges

As mentioned earlier, the financial crisis of 2008 has introduced some unique challenges in prepayment modeling. These have to do with government intervention in the mortgage market, unprecedented influence of involuntary prepayments, very strict underwriting standards, ebb and flow of alternative mortgage products, the roller-coaster housing market, re-emergence of Private Mortgage Insurance (PMI), and the increased share of Veterans Administration (VA) loans in GNMA origination.

Several government programs were initiated to help home owners with their ability to refinance, particularly if the impediment was high levels of LTV due to home price depreciation. Conforming mortgage borrowers who are consistent with their monthly payment could take advantage of the HARP program even if they lack equity in their home to get refinance through regular channels. HARP is beneficial only for loans endorsed prior to May 31, 2009. This program essentially divides the prepayment experience into two distinct groups: (1) HARP-eligible loans and (2) HARP-ineligible loans. Obviously, treating the two as one unified data set will result in inferior and misleading models.

Nowhere is the impact of government intervention more evident than in the Federal Housing Administration (FHA) changes to the Mortgage Insurance Premium (MIP). The FHA charges one-time Upfront MIP (UMIP) and an Annual MIP (AMIP) for all loans in exchange for a government-backed credit guarantee.

Table 26.3 shows how the UMIP and AMIP have evolved since 2001. Although loan defaults were rapidly mounting, FHA did not raise the insurance premium till April 2010 when the UMIP was raised by 75 bps to 225 bps, keeping the AMIP flat at 55 bps. Over the next year, the FHA made incremental changes to the program, raising AMIP to 115 bps, but reducing UMIP to 100 bps. In April 2012 the FHA again modified the premium with a cut-off date for loan endorsement. Loans endorsed prior to May 31, 2009 (same as the HARP cut-off date for conventional loans) were grandfathered under this program, being charged only 1 bp for UMIP and 55 bps for AMIP. Loans endorsed after this date will be paying 175 bps and 125 bps, respectively, for UMIP and AMIP. Since then, the FHA has revised the "post-HARP" AMIP twice—in April 2013 to 135 bps and again in January 2015, lowering it to 85 bps.

It should be obvious that any material change to the insurance premium structure will elicit a response from FHA borrowers who are interested in refinancing their loans. Depending on the direction of the premium changes, prepayments are either going to increase or decrease even if interest rates remained unchanged. This poses a problem for the modeler who is trying to extract a relationship based on a regression model alone.

Table 26.3 FHA Mortgage Insurance Premium (MIP) requirements for 30-year FHA loans with LTV ratio greater than 95%

Effective/Announcement Date	Upfront MIP (UMIP) bps	Annual MIP (AMIP) bps
1/1/2001	150	55
10/1/2008	150	55
4/1/2010	225	55
10/4/2010	100	90
4/16/2011	100	115
4/9/2012	1	55
(Pre 5/31/2009 Endorsement)		
(Post 5/31/2009 Endorsement)	175	125
4/1/2013		
(Post 5/31/2009 Endorsement)	175	135
1/8/2015		
(Post 5/31/2009 Endorsement)	175	85

Source: FHA, Performance Trust Capital Partners, LLC

To illustrate this point further, consider Figure 26.5 which shows the prepayment seasoning pattern of GNMA II, 30-year fixed-rate loans that have an AMIP of 60 bps or less and LTV ratio greater than 80%. Prepayment speed is subdued till around 60 months of seasoning, when it jumps from about 5.0% CPR to well above 30.0% CPR. At first glance it may appear purely to be a function of loan seasoning. However, that is incorrect. At the time this chart was prepared, in early January 2015, the 60 months of seasoning roughly represented the cut-off date of May 31, 2009. Loans older than 60 months were grandfathered under FHA rules and needed to pay only 1 bp UMIP and 55 bps AMIP. As many of these legacy loans have high note rates, borrowers took advantage of the FHA policy and refinanced into lower-coupon mortgages. As a result, prepayment speed rose sharply at 60 months of seasoning. One can imagine how badly this will impact a regression model unless the modeler finds a way to censor the data!

Prior to the financial crisis, involuntary prepayments were not a significant consideration. Not anymore. Although serious delinquencies are down from their peak levels, they are still an important consideration in determining Buyout CPRs. Loans are usually bought out of an MBS pool once they are more than 90 days delinquent. This action results in prepayment referred to as Buyout CPR. Figure 26.6 shows Total CPR and Buyout CPR for seasoned GNMA II loans. In this case, the Buyout CPR is often as much

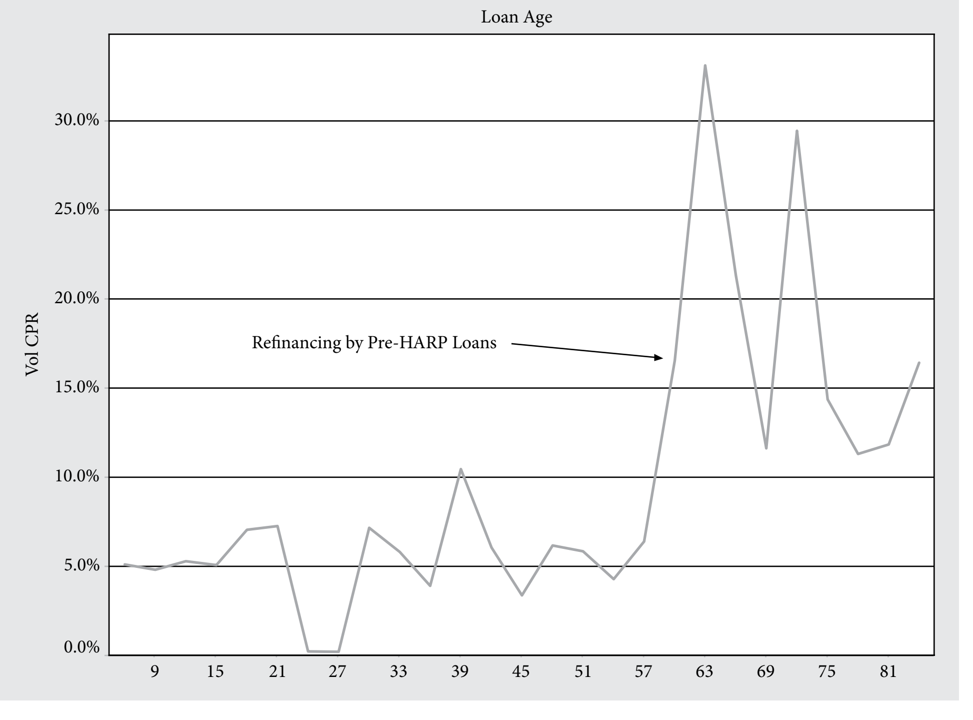

FIGURE 26.5 GNMA II, 30-year fixed rate—Voluntary CPR (Annual MIP < 60 bps, updated LTV > 80%, 1/2014 through 1/2015 reporting period)

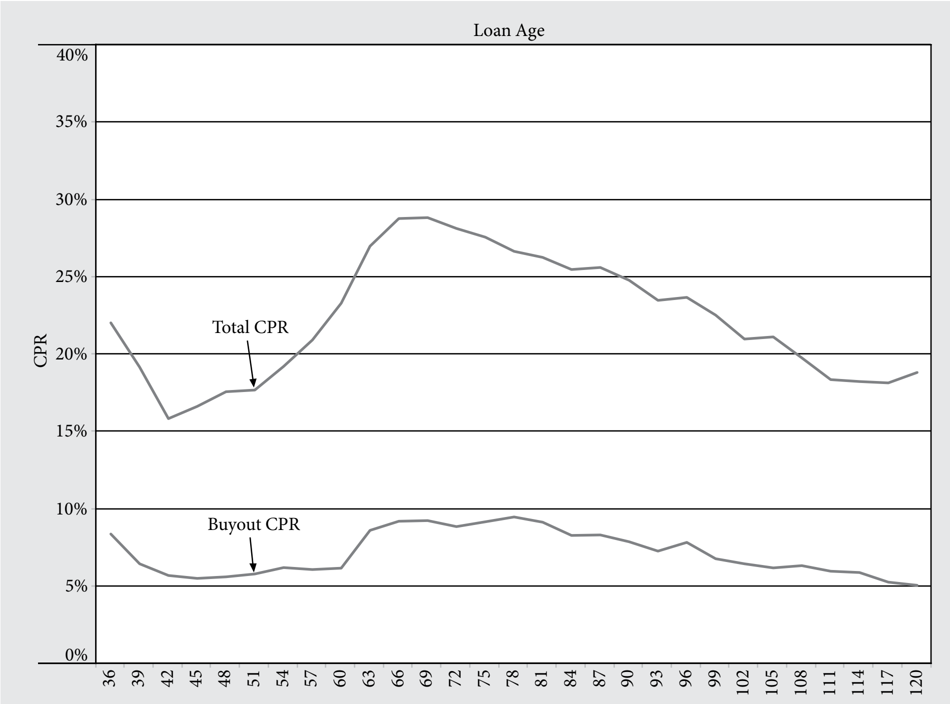

FIGURE 26.6 Total and Buyout CPR of seasoned GNMA II, 30-year fixed-rate loans (1/2014 through 1/2015 reporting period)

as 30% of the Total CPR. The difference between the Total CPR and the Buyout CPR represents the actual Voluntary CPR. The Voluntary CPR is the critical input data for the loan-level prepayment model, while the Buyout CPR should be predicted separately from a loan-level default model.

Underwriting standards have been very strict since the financial crisis. This is particularly true for 2009, 2010, and the first half of 2011. Anecdotal evidence points to the possibility that this period had the strictest underwriting in the history of the MBS market. As a result, the voluntary prepayments observed during this period were rather subdued compared to what we would expect in a more "normal" underwriting environment. So, if the data during this period are used in creating a prepayment model, allowance must be made for easier underwriting in the future.

Prior to the financial crisis, alternative mortgage products played a big role in mortgage refinancing. Often these loans were labeled as "affordability" products which reduced the borrower's near-term monthly payments in exchange for increased payments in the future. Before 2008, products like interest-only and option adjustable-rate mortgage (ARM) loans allowed borrowers to purchase pricier homes than they would qualify for under a regular 30-year fully amortizing loan. Investors speculating in real estate often used the super-low initial payment of an option ARM mortgage as a kind of a short-term bridge loan till they were able to flip their investment properties and pay off the outstanding balance. Often borrowers piled on a home equity line of credit (HELOC) as a second lien to further leverage their borrowing ability.

All this came to an abrupt end when home prices started declining rapidly. In fact, many of these exotic products were among the first to default as the real estate market soured. These product offerings simply disappeared by end of 2008.

Between 2009 and 2011 mortgages other than the 30-year and 15-year amortizing loans were rare. With solid recovery of the housing market since mid-2011, some alternative products have reappeared, albeit at a slow pace. Fixed-rate jumbo and hybrid 5/1 and 7/1 ARM origination has picked up somewhat. Since the 30-year mortgage rate has been very low by historical standards, ARM loans are garnering a relatively small market share. If there is substantial increase in fixed mortgage rates, hybrid ARM share is likely to increase. Notwithstanding the hybrid ARM situation, according to results published by FHLMC, between 30% and 40% of 30-year refinances have been routinely going into 20-year or lesser maturity products since 2011.

Another transition that has been trending strongly since 2012 is the move away from FHA loans into conventional loans. Partly driven by onerous mortgage insurance payments, better-credit FHA borrowers have been opting for conventional loans. The FHA-to-conventional refinance transition grew to about 60% in mid-2013 and topped 80% by August 2014 (Figure 26.7). The re-emergence of Private Mortgage Insurance since 2012 made this possible. With rising home values, PMI issuers have been able to offer insurance at rates substantially lower than FHA mortgage insurance, resulting in the transition to conventional loans.

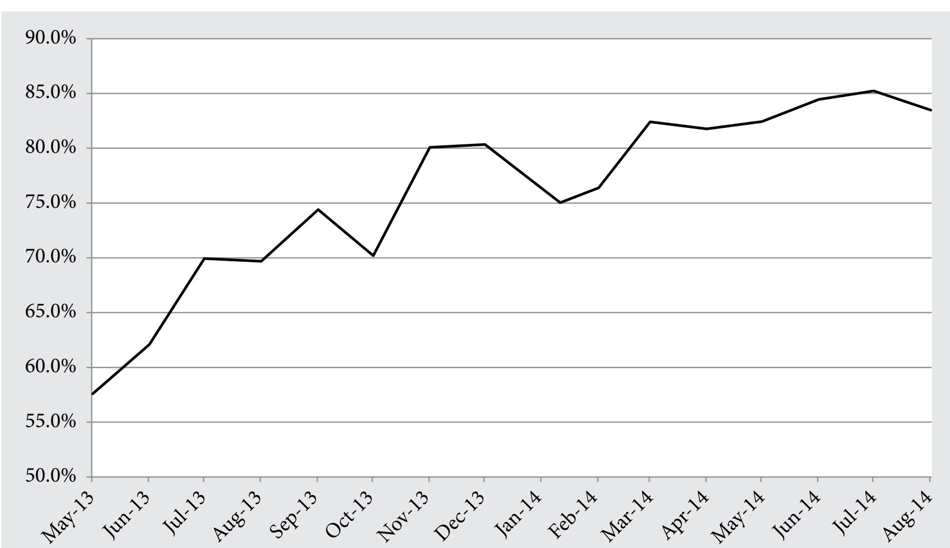

FIGURE 26.7 FHA to conventional refinance transition

Note: The computation assumes a 5.0% CPR base turnover rate

Source: FHA, Performance Trust Capital Partners, LLC

A trend worth mentioning is the increasing share of Veterans Administration loans in GNMA origination. Till around 2010, only about 10% of GNMA origination was VA loans, with the FHA responsible for 80% of the remaining volume and the Rural Housing Services (RHS) provided another 10%. Since then, the VA share has steadily increased to around 50% by end 2014. FHA share has decreased to about 40% with RHS holding onto its 10% share. The increase in VA share is partly the result of the increasing number of veterans returning from foreign wars using the VA housing benefits and also the transition of FHA borrowers to conventional loans, as discussed above. VA borrowers have an entirely different prepayment profile compared to FHA borrowers. With the VA share of new origination being this high, modelers cannot treat GNMA pools as homogeneous any more. Only loan-by-loan analysis can reveal the true prepayment potential of GNMA loans.

Qualified Residential Mortgage (QRM) rules announced in October 2014 as part of Title IX of the Dodd-Frank Act are a key determinant in the future of alternative mortgage products. QRM requires that 5% of loans eligible for sale in the secondary market for securitization must be retained by the originator, unless they meet standards exempting them from risk retention. This "skin in the game" requirement does not bode too well for Alternative-A and subprime origination the likes of which we saw prior to 2008. In addition, government-sponsored entities like FNMA, FHLMC, and GNMA have actively invoked "put-back" clauses in legacy loans that may have been deficient in underwriting quality, forcing several major originators to buy back the loans. This has made originators rather reluctant to relax underwriting standards if they intend to securitize these loans under the agencies' label. However, there is active consideration by authorities like the Federal Housing Finance Agency (FHFA) to relax the put-back requirements in order to revitalize the mortgage origination market. Should this occur, models will need to be recalibrated as this is likely to have a material impact on prepayment speeds.

Loan-Level Modeling

The task of modeling loan-level prepayments involves regression of prepayment behavior versus loan-level parameters. *Survival analysis* offers one of the possible approaches to loan-level prepayment modeling. Details of this method are presented in the appendix to this chapter. These models incorporate statistically significant loan parameters as input data. Stated simply, the analysis involves figuring out a so-called age-dependent "baseline" prepayment function representing average parameter values for the full analysis data set. The baseline can be modified for increasing or decreasing interest rate scenarios—away from the historical mean levels. At extreme levels of increasing rate scenarios, the baseline would represent the so-called "turnover" prepayment. For lower rate scenarios, this will include a refinance component as well as a turnover component.

The loan-level modeling process involves determining the long-term impact and relative importance of loan parameters on aggregate or mean levels of prepayment speeds.

Table 26.4 depicts the relative impact of the change of loan-level parameters for FHLMC 30-year fixed-rate conforming loans, based on a fairly simple yet robust loan-level estimation. The period of analysis is from July 2012 through January 2015. During this interval, many of the "abnormal" aspects of the impact of the financial crisis have dissipated. In our opinion, this period provides a fair degree of consistency of behavior that can be modeled using loan-level data. Also, during this time frame there were a decent amount of in-the-money and out-of-money observations, making this model applicable to both refinance and turnover refinance estimation.

The results shown in Table 26.4 are based on five loan-level parameters—refinance incentive, loan age, loan size, updated LTV, and FICO score. The relative impact of each parameter is expressed as a decimal percentage deviation from a base level.[4] For instance, the 30-year conforming loan size effect is 28% greater when the loan amount is $200,000 compared to when it is $150,000. Similarly, a FICO score of 700 will only have 60% of the speed impact of a score of 750.

Adding more parameters, such as geography or SATO, may not necessarily improve the predictive power of the model. Geography may be correlated with HPA (which is already built into updated LTV) and SATO may be negatively correlated with FICO. Often, adding too many variables that are strongly correlated with each other leads to a model that overfits data within sample, but performs poorly out of sample.

Caution must be exercised in the use of prepayment models. A regression model can only replicate the mean prepayment behavior given the range of loan-level data used in the regression. One cannot expect the model to be very accurate for parameter values that are outliers, such as several standard deviations away from the average observation. However, loan-level prepayment modeling is more accurate than pool-level modeling due to the fact that explanatory power increases with the inclusion of individual loan parameters. The benefits of using obligor and property data are significantly greater when the underlying loan parameters are widely dispersed and skewed.

Table 26.4 Relative response of loan-level parameters (FHLMC 30-year conforming model—7/2012 to 1/2015 reporting months)

Refinance Incentive (bps)		Loan Age (months)		Loan Size ($)		Updated LTV Ratio		FICO Score	
−100	0.10	10	0.50	$75,000	0.64	70%	1.16	700	0.60
0	0.80	20	0.70	$150,000	1.00	77%	1.00	720	0.72
100	1.00	36	1.00	$200,000	1.28	80%	0.86	735	0.84
150	1.25	50	1.16	$250,000	1.45	90%	0.80	750	1.00
200	2.20	60	1.22	$300,000	1.60	100%	0.62	775	1.22

Source: FHLMC, Performance Trust Capital Partners, LLC

[4] In the interpretation of these results, the effect of each of these variables is evaluated holding the effect of other explanatory variables constant.

Key Points

- Building prepayment models using loan-level information offers a better understanding of prepayment potential compared to aggregated pool-level information.
- Parameters such as loan-to-value ratio, FICO score, loan size, borrower documentation, and many others have a profound impact on prepayment performance and should be carefully analyzed when they are incorporated in a model.
- Government initiatives and programs implemented since the financial crisis have introduced complications that make prepayment modeling ever more challenging.
- Data must be censored carefully to remove biases introduced by these programs, prior to their use in models.
- As the mortgage market evolves toward more normal lending conditions, models need to be recalibrated to account for easier lending standards and evolution of alternative mortgage products. This is particularly true of private-label (non-agency) mortgages, which are likely to have a major impact on prepayment speed once the non-agency market becomes fully functional.

APPENDIX

Use of Survival Analysis in Loan-Level Modeling

Survival analysis encompasses a large variety of statistical methods for studying the positive random variables that can describe the timing and occurrence of random events. Those events could be death, equipment failure, mortgage prepayments, stock market crashes, accidents, and unexpected life insurance payments, to name a few.

Survival Function

Survival analysis requires the understanding of three functions: a survival function, a hazard function, and a probability density function. The three functions are related to each other, and given one of them, the other two functions can be derived. Intuitively, the three functions can be defined in the context of mortgages as follows:

- *Survival Function*: represents the number of loans that are left in a pool in comparison to the original number of loans.
- *Hazard Function*: represents the number of loans that are paid off in a pool in comparison to the number of loans in the previous period of reference.
- *Probability Density Function*: represents the probability distribution of continuous variable T, the survival time for a loan (before it is paid off). Denote f as the probability density function of the variable T. The survival function $S(t)$ is defined as the probability of an individual loan surviving longer than t:

$$S(t) = P(T > t)$$

This function can be estimated by the empirical survivor function:

$$S_{emp} = \frac{\text{(Number of loans at the month t)}}{\text{(Total original number of loans in the pool)}}$$

The hazard rate or hazard function (i.e., the instantaneous failure rate) h(t) is given by the formula:

$$S(t) = \exp(-\int_0^t h(s)ds)$$

or:

$$\mathrm{h(t) = -\,d(log(S(t)))\,/\,dt}$$

Assuming that h(t) is a constant, then the function S(t) has the simple expression $\mathrm{S(t) = exp(-ht)}$. This implies that the hazard function could be considered as the decay rate of the mortgage pool.

The hazard function could also be defined by:

$$h(\mathrm{t}) = \lim_{\Delta \mathrm{t} \to 0} \frac{\mathrm{P(t \le T < t + \Delta t \,|\, T \ge t)}}{\Delta \mathrm{t}}$$

Given that the borrower has not paid off until time t, h(t) is the probability that the borrower will pay off in the time interval t and $\mathrm{t + \Delta t}$.

Using the finite difference approach in the discreet time intervals $\Delta \mathrm{t}$, the hazard rate h(t) is replaced with its discreet approximation $\mathrm{h_d(t)}$.

$$h_d(t) = \frac{(S(t+\Delta t) - S(t))}{S(t)} = \frac{Number\ of\ paid\text{–}off\ loans}{Number\ of\ loans\ at\ time\ t\ \ (beginning\ of\ the\ month)}$$

The typical interval $\Delta \mathrm{t}$ in mortgages is a one-month period.

Denote B(0) as the original balance of the pool and B(t) as the current outstanding balance. The pool factor is the ratio of the mortgage pool remaining principal balance to the mortgage pool original balance. The notation is as follows:

$$\mathrm{PF(t) = B(t)\,/\,B(0).\,t}$$

Note that the survival curve mimics the pool factor associated with mortgage loans.

Model Description

The hazard function can be described by parametric and nonparametric methods. The survival function can be described by general probability distributions such as the exponential, Weibull, and lognormal distribution. However, the most flexible way to model hazard functions is through the use of nonparametric models.

The hazard function can be modeled as follows:

$$h(t,\beta) = h_0(t)\gamma(t,\beta),$$

$$\gamma = \exp\left(\sum_{i=1}^{n} \beta_i(t) x_i(t)\right)$$

where $h_0(t)$ is the baseline hazard function, $X=(x_1, x_2,...x_n)$ is the vector representing individual loan characteristics, and $\beta_1,\beta_2,\beta_3,\ldots\beta_n$ are the coefficients that indicate the influence of loan characteristics on prepayments. The baseline hazard rate $h_0(t)$ is a common function to all mortgage loans and is often defined in such a way that it corresponds to a case in which all covariates (loan attributes) are set to their means.

The simplest approach is to use the proportional hazards model. This implies that function γ is independent of time t. The terminology "proportional hazards" is derived from the fact that the hazard rate for one loan is a fixed proportion of the hazard for any other loan. This method is called a Cox regression model and this simple scaling allows the baseline level to be aligned to predefined variables.

It can be easily seen that γ can be represented in the form:

$$\gamma = \gamma_1 \gamma_2 \gamma_3 ... \gamma_n$$

where $\gamma_i = e^{x_i \beta_i}$. This means that if the coefficient β_i is negative, then the multiplier γ_i is less than one, assuming x_i are positive. It means that this variable is responsible for the reduction of prepayments relative to the base case. The opposite is true for positive β_i coefficients.

Propensity to Prepay

The identification of the multiplier γ for each individual loan and the value of this multiplier determine the level of prepayments compared to the baseline level. This multiplier can be denoted as the propensity to prepay for each individual loan. It is clear that if γ is greater than 1 for a loan, then the loan has a higher prepayment speed than the base case; if γ is less than 1 for a loan, then the prepayment speed will be lower than the base case. In the first case, the loan has a higher propensity to prepay while in the latter case the loan has a lower propensity to prepay.

CHAPTER 27

ISSUES AND CHALLENGES IN NON-AGENCY MORTGAGE SECURITIZATIONS

ANAND BHATTACHARYA AND BILL BERLINER

After reading this chapter you will understand:

- that in the aftermath of the financial crisis, the supply of "non-agency" or "private-label" MBS has been anemic and as of 2016 continues to languish;
- the revised definition of the sector only includes non-GSE insurable loans;
- the only significant source of MBS supply has been securitizations by some non-bank financial institutions, such as real estate investment trusts, in addition to periodic transactions by dealers;
- that lack of clarity and synchronization between various elements of the Dodd-Frank Act relating to the quality of loan originations have contributed to the anemic growth of the sector;
- that despite recent clarification of some of the mortgage origination rules, the issue of whether these loans can be economically securitized has not been resolved;
- that the subordinated risk retention mechanism has implications for the types of entities that are likely to be involved in the securitization of non-GSE insurable loans;
- that additional progress also needs to be made with respect to investor demands such as enhanced reps and warranties and standardization of pooling and servicing agreements;
- that it is likely the future of the non-agency market may be characterized by much lower volumes and comprised mainly of "private placements" with the majority of the subordinated credit risk retained by the issuer.

In the aftermath of the financial crisis, the "non-agency" or "private-label" mortgage-backed securities (MBS) market may best be characterized as the "tale of two cities." Since 2008, the supply of non-agency MBS has been "anemic" at best. At the same time, legacy non-agency securitized structures have continued to pay down without any replenishment of supply. While there has been some issuance of non-agency securities, the supply has essentially been a trickle and the market continues to languish at a fraction of the volumes attained prior to the financial crisis.

The purpose of this chapter is to explore the various environmental, regulatory, and operational issues associated with this phenomenon with a view toward assessing the future viability of this sector of the securitized markets. We attempt to do this by exploring issues on both the supply and demand side of the equation. Our crystal ball indicates that despite the resolution of regulatory issues, banks are likely to continue to originate loans mainly for portfolio purposes or for disposition as whole loans. Since such entities use securities markets as a funding source, the inclusion of regulatory, disclosure, and compliance costs along with higher subordination levels likely make the securitization option uneconomic. The participants in this market are likely to be mainly real estate investment trusts (REITs) along with opportunistic transaction by dealers. At the same time, a host of issues ranging from additional investor safeguards (such as enhanced reps and warranties), advanced monitoring and compliance mechanisms, pricing transparency along the credit curve, and secondary market liquidity have to be resolved in order to instill investor confidence in this sector. Until such time, the securitization model will likely depend upon the retention of subordinated risk by the issuer. As such, it may be a while (and possibly never) before volumes in the non-agency market are robust enough to make this sector a viable component of securitized markets once again.

There has been a precipitous decline in non-agency MBS volumes resulting from the financial crisis, which first reached widespread attention in early 2007. As noted by the Securities Industry and Financial Markets Association (SIFMA), even as agency MBS issuance declined less than 2% in 2008, private-label mortgage issuance declined from $506.7 billion in 2007 to $8.9 billion in 2008. Since then, non-agency MBS issuance has been anemic at best.

As a starting point, it is instructive to note that in the current environment (versus pre-financial crisis) a certain amount of constriction in supply should be expected, since certain types of loans, such as subprime and Alt-A loans, are not being originated in any significant volumes. Loans now most likely to be securitized under this category are non-GSE insurable loans, such as jumbo-balance mortgages. Within this arena, the only significant source of MBS supply has been securitizations by some non-bank financial institutions, such as REITs, in addition to periodic transactions by dealers. In REIT securitizations, which are collateralized by assets of very high credit quality, the subordinated risk is retained by the issuers. Note that in such securitizations, the pricing of the subordinated risk is internal to the issuer and such information is not widely available to the securitized markets. As such, it is difficult from the outside looking in to make an educated assessment about the economics of non-agency securitizations. Other lenders, such as banks, have mainly been originating such loans for portfolio purposes and not securitizing the assets. The reasons behind the lack of securitization activity by banks likely include higher costs of due diligence and enhanced disclosure, the regulatory uncertainty created by the lack of resolution with respect to risk retention, and capital requirements favoring whole loan retention. The risk retention requirements refer to the portion of risk that is required to be retained by sponsors of asset securitization, as mandated by the Dodd-Frank Act that was signed into law in 2010. It is only recently that regulatory agencies have reached definitive conclusions with respect to these rules.

Resolution of Regulatory (QM and QRM) Issues

As part of financial reform, the Dodd-Frank Act requires regulatory agencies to define both a Qualified Mortgage (QM) and Qualified Residential Mortgage (QRM). The former designation relates to the ability and capacity of the borrowers to repay the mortgage loan, while the latter refers to the type of mortgages that can be securitized without the issuing entity retaining a portion of the credit risk of the underlying mortgages. The QM definition was enacted in January 2014 and is currently being implemented by the industry. QM mortgages are defined as mortgages originated with full documentation, a debt-to-income ratio of not more than 43%, and origination points and fees of less than 3% of the loan amount. They must also be devoid of features such as negative amortization, interest-only and balloon payments, and terms longer than 30 years. All loans eligible for purchase or insurance by the GSEs are considered QM-eligible irrespective of the debt-to-income ratio. Additionally, loans originated by institutions with less than $2 billion in assets and a maximum lending amount of 500 or fewer mortgages are also considered QM loans as long as such loans are held in portfolio and the borrower debt-to-income ratio has been verified. Loans that are compliant with QM requirements provide the lender with safe-harbor protection against legal challenges with respect to the institutions' assessment of the borrowers' ability to pay at the origination of the loan. Non-QM loans do not insulate the lender from such legal challenges in the future. Hence, the non-QM lending paradigm is based upon the assessment of the risks inherent in future legal challenges regarding the assessment of borrower ability to pay compared to the reward most likely manifesting in higher loan rates.

While the resolution of the definition of QM-eligible loans provides clarity for lending at the primary level, it does not resolve the issue of whether these loans can be economically securitized. Given the universe of QM-eligible loans, the resolution of the securitization-related issues falls within the definitional purview of another rule, namely the QRM requirement, which describes the types of loans that can be securitized without the lender retaining part of the risk. The idea here was to repeal the moral hazard issues of default and delinquency created by lenders originating loans for securitization without having "any skin in the game" (i.e., any economic interest in the credit performance of the loans). The Dodd-Frank Act mandated that regulatory agencies require sponsors of securitizations of loans that do not qualify as QRM-compliant to retain at least 5% of the credit risk of the assets in the securitized structures. In August 2013, six federal agencies announced two new proposals to the QRM rule after incorporating industry comments from previous versions of the definition. The first of these proposals would align the definition of QRM with QM, while the alternative approach would require lenders to retain a portion of the credit risk when mortgages originated without at least a 30% down-payment are securitized. The comment period for these proposals ended on October 30, 2013 and regulators finalized the rules in 2014. The final rules align the definition of QRM with that of mortgages originated under the QM rules. In other words, QM mortgages are also considered to be QRM-compliant, and hence, sponsors of QRM securitizations would be exempt from risk retention requirements. Implementation of these rules for residential mortgages was slated to begin in December 2015.

For loans which are not QRM- (and QM)-compliant, the sponsor of the securitization is required to retain a minimum of 5% of the credit risk associated with the loans. In retaining this risk, the regulations allow the sponsor of the securitization to shape the form of risk retention by either retaining a "horizontal" or "vertical" interest or retaining a combination of such interests, also referred to as an "L"-shaped interest. In the horizontal risk retention scheme, the sponsor is required to hold the most subordinate 5% interest, i.e., a first-loss tranche. Additionally, this scheme also requires the sponsor to disclose the fair value of the retained interests and methodology used in determining such fair value. As an alternative, the sponsor may choose to fund an account with a cash balance equal to the market value of the retained first-loss interest. The funds in the cash account are restricted to ensure that the cash in the account is available to withstand credit losses. In the vertical retention scheme, the sponsor may either retain at least 5% of each securitized class (both senior and subordinate) or a single vertical security that is comprised of 5% of each issued class. The vertical retention scheme is not subject to the fair-value disclosure requirements as is the case with the horizontal risk retention method. Sponsors may also combine vertical and horizontal interests to meet the 5% risk retention requirement.

The choice of whether the risk retention is "vertical" or "horizontal" has implications for the supply of non-agency securitized MBS. Recall that the vertical scheme refers to holding a *pro rata* portion of the loans being securitized while the horizontal alternative refers to effectively holding the first-loss tranche of the securitization. For instance, if a 5% vertical interest is held, any losses would be applied *pro rata* to the retained portion of the individual tranches. However, under the horizontal scheme, the originator would effectively be in the first-loss position of up to 5% of the losses. As such, under the vertical scheme, in the event losses are 5% on the underlying collateral, the writedown of the assets would be 5% of the 5% loss = 0.25%, or $250,000 on a $100 million transaction. However, in the horizontal scheme, the loss of 5% would apply to the entire 5% risk retention piece, or a $5 million loss on the same deal. Therefore, the horizontal retention scheme has the effect of potentially causing the retained assets to be more leveraged and hence significantly riskier.

As such, the form of risk retention utilized has implications for the types of financial institutions likely to be involved in the origination process and the loans likely to be originated by these institutions. For financial institutions such as banks, which view the securitized markets as a funding source, the implementation of the horizontal model is likely to result in lower proceeds from securitization and negatively impact their ability to originate loans for the securitized markets. Additionally, under this scheme the sponsor of the securitization has to disclose the fair market value of the retained assets and the methodology used in determining the resulting valuation. For banks, the adoption of this scheme of risk retention is also likely to result in higher capital requirements. As such, it is our contention that banks are likely to gravitate toward the vertical risk retention model. This prediction also is strengthened by the fact that vertical risk retention does not require the valuation of these assets nor the disclosure of the valuation methodology, as is the case with horizontal risk retention. As such, under the vertical risk retention model, banks are unlikely to be faced with higher capital requirements and regulatory scrutiny.

In this vein, another related and important question concerns the motivation for regulated entities such as banks to originate non-QRM-compliant (and by definition non-QM-compliant) loans, given the potential future liability associated with the possible nonperformance of such loans. This observation is particularly relevant given the aggregate fines and settlements paid by banks to resolve underwriting-related issues during the housing crisis. While some banks may positively view the risk/reward trade-off in underwriting non-QM loans to creditworthy borrowers, it is still debatable whether banks will be regular participants in the non-agency securitized market. The reasons for this contention stem from rules under Basel III capital regulations, where the value of mortgage servicing assets can comprise up to a maximum of 10% of an institution's Tier I capital, which is more stringent than the current 50% cap. In view of these rules, some banks may choose not to securitize and retain such loans as portfolio assets, as this option does not create a separate servicing asset. In light of this observation, banks are likely to originate loans to high-quality creditworthy borrowers as such loans will be retained in the portfolio of the bank. In this scenario, it is also debatable whether the loans originated by banks will be fixed-rate 30-year mortgages, as such loans are inconsistent with bank asset/liability-matching programs which typically use short- to intermediate-term funding. As such, banks may offer competitive pricing on shorter-dated mortgages, such as 15-year loans and 5/1 hybrid ARMs. The public policy implications of such possible developments regarding constriction of credit, effect on housing demand and the flow of private capital to the mortgage markets will, we believe, be subject to much speculation and conjecture.

Alternatively, we expect that the horizontal model is likely to be used by REITs, which after the financial crisis have been one of the active users of the securitization strategy in the otherwise moribund non-agency MBS market. In recent years, due to heightened regulatory scrutiny, regulated institutions such as banks have withdrawn from certain mortgage origination channels, notably the wholesale lending channel. Some of this slack has been picked up by REITs through the origination of mortgages in the wholesale channel neglected by banks. As such, the economic model for many REITs has been to securitize mortgage production while holding the subordinated classes, which has the same effect as retaining a horizontal risk retention tranche. From a moral hazard perspective, this strategy is viewed favorably by investors in securitized mortgage assets, as the retention of the subordinated tranches signifies "skin in the game." Any non-QM loans originated under such circumstances are likely to be associated with high-credit-quality obligors, whereby the risk retention by the sponsor is motivated by the attractive risk–return profile. While these types of securitizations are likely to continue, this source of non-agency MBS supply is likely to be opportunistic, as the ability of such institutions to continue to retain subordinated risk is not unlimited. As such, due to the limitations associated with the supply of non-agency MBS issued by REITs, this model cannot be depended upon to be a permanent, viable, and regular source of non-agency MBS supply.

Our prediction regarding the types of entities likely to gravitate toward the horizontal or vertical form of risk retention still begs the question of investor partialities regarding sponsor risk retention. Arguments for the horizontal risk retention format are that since the sponsor of the securitization is in the first-loss position, the agency problem of badly underwritten loans and fraud in the origination of such loans is mitigated. As such, this model of risk retention is likely to be favored by investors in the higher-rated tranches. On the other hand, since the vertical risk retention format requires the sponsor to hold a *pro rata* share of all securities, the implementation of this model would then protect the interests of all security holders. In the absence of significant demand for lower-rated tranches, it is likely that in the event of any resurgence of the non-agency MBS market, the horizontal structure will dominate until such time as demand for lower-rated tranches develops in any significant fashion.

Investor Preferences and Rating Agency Dynamics

Given the worse than expected performance of securities rated at the higher end of the rating spectrum (at least relative to their ratings) and the dismal performance of securities at the lower end of the rating scale, the breadth of demand for non-agency MBS is still an unanswered question. It is also fair to assume that some investors, particularly those that suffered losses on higher-rated securities, may not participate in this sector of the securitized markets and seek yield opportunities elsewhere. Investors that seek active participation in this market are likely to demand enhanced reps and warranties to ease fraud and put-back resolution and a stronger role accorded to the trustee in the management of the Pooling and Servicing Agreement (PSA). Investors are also likely to demand a higher degree of granular performance data over the life of the deal, as well as more accessible sources of such data. Given the anemic issuance in this sector, certain investors may not participate in non-agency securitization for fear of reduced liquidity. However, for there to be a higher degree of liquidity, a necessary condition is increased investor participation. Given the current state of the market, it is not clear as to the catalyst that is required for solving this "chicken or egg" dilemma.

With respect to investor protection, it is instructive to highlight the tenets of the recent finalization of data disclosure rules by the Securities and Exchange Commission (SEC) regarding asset securitizations. In August 2014, the SEC adopted final rules that significantly revised existing regulation (commonly referred to as "Regulation AB") with respect to disclosure requirements, offering processes, and periodic reporting for asset-backed securities. The change in these rules was motivated by the enactment of the Dodd-Frank Act (DFA). Under the new rules, issuers are required to provide standardized asset-level information regarding the credit quality of the obligors, the collateral associated with each loan, and cash flow projections associated with the deal. Additionally, the rules also require the description of dispute resolution mechanisms and an independent review of the reps and warranties associated with the assets upon the occurrence of certain trigger events. While such measures certainly protect investor interests, these rules also beg several questions regarding the identity of the monitoring and dispute resolution agencies. Are trustees the logical players in securitized markets to be accorded the role of being the monitors and arbitrators of asset-backed structures? If so, are the trust companies willing and able to assume this role? Do these entities have the infrastructure and bandwidth for such tasks? What are investor preferences regarding the identity of these deal monitors? Additionally, under the revised Regulation AB rules, the CEO of the sponsor must also attest to the personal review of documentation and material facts of the securitization. It must also be noted that such disclosures translate to additional cost and potential liability for the issuer, notwithstanding the clear positive benefits accorded to investors. It is therefore reasonable to conclude that the only issuers likely to use the securitization alternative will be those who either do not have access to alternative funding sources or are not in a position to portfolio such assets.

At this point, it may be instructive to shed some light on the costs of asset securitization. The ability of an issuer to obtain higher proceeds from the sale of securitization or a lower funding cost is a function of the "splits" or the tranched level of subordination (both investment grade and below investment grade), the rating given to each tranche, and the dollar price associated with such tranches. As a general rule, the proceeds from securitization are higher in a regime of lower subordination levels; absent a difference in how the tranches are priced, less subordination means that fewer bonds must be sold at the lower prices garnered by subordinate bonds. In the aftermath of the housing crisis, the rating agencies are faced with the issue of determining subordination levels which can withstand severe economic and housing scenarios in an environment where the credibility of these agencies has been called into question. Therefore, it is not unreasonable to conclude that rating agencies are likely to use a "belt and suspenders" approach toward rating such securitizations, focusing on both the granularity of data and the "downside" of the underlying collateral. As such, a possible scenario is that the subordination levels determined by the rating agencies will be onerous enough to negatively affect the economics of securitization, especially in an environment where investor demand for subordinate securities may best be described as uncertain. Herein lies a reason for banks, which primarily use the securitization markets as a funding source, to eschew the securitized markets to monetize assets and either originate loans to hold in portfolio or for disposition as whole loans.

An alternative scenario is a lack of interest by investors in subordinate tranches under the belief that the subordination levels determined by the rating agencies are not onerous enough to cushion extreme-case housing price shocks and/or a downturn in economic activity. The manifestation of this scenario would likely also affect the demand for subordinate securities, resulting in lower all-in proceeds for issuers. As such, it is not clear how this interplay between subordination levels and investor interest in such bonds is likely to be resolved. Nonetheless, it is clear that the resolution of this issue also requires that computed subordination levels and additional diligence and monitoring costs not drastically affect the economics of securitization for the issuer.

One element in the Dodd-Frank Act had an immediate impact on issuance of non-agency MBS. A section of the Act specifically rescinded Rule 436(g) of the Securities Act of 1933, which was added as an amendment in 1982. The rule effectively shielded rating agencies from liability in the case that errors and omissions were later discovered, and as a result, issuers could include ratings information in the offering materials of the public offerings of deals without the consent of the rating agencies. The reporting requirements of public transactions in fact require that ratings be included in the registration statement. With the passage of the Act, the rating agencies no longer gave their consent to include the ratings in the offering materials, meaning that issuers could no longer bring public deals to the market. The SEC addressed this conundrum by issuing a no-action letter that allowed issuers to omit credit ratings from the offering materials. (The initial no-action letter was effective until January 2011, but the relief was extended indefinitely in November 2010 and remains in effect at this writing.) Attempts to permanently address the conflict between DFA and the reporting regulation have so far been unsuccessful,[1] adding another source of uncertainty to the recovery prospects of the non-agency MBS market.

In view of these circumstances, it is entirely possible that originators, particularly banks, may resort to selling production as whole loans and/or originate loans only for investment purposes. Given the current uncertain securitization environment, the whole loan sale offers a better alternative as a liquefaction strategy. While whole loan sale execution may be a viable alternative for some originators, the settlement process for such sales is fairly cumbersome. Additionally, the investor base for such sales is limited to financial institutions.

[1] The Asset-Backed Market Stabilization Act of 2011, introduced into the House of Representatives in part to address this conflict, was never brought to a vote.

Public versus Private Securitizations

In the period prior to mid-2007 when issuance of non-agency securities was robust, virtually all deals were issued as public securities. Despite the registration and reporting requirements associated with such deals, they were relatively liquid and convenient to value, and had no limits on the investors that could buy tranches from these deals. Issuers had the option of issuing "private placements" under rule 144A of the Securities Act of 1933, which had significantly lower initial costs and ongoing reporting requirements. However, tranches from such deals could only be sold to "qualified institutional buyers" (QIBs), and the liquidity of these deals was significantly worse than for public deals.

At this writing, however, virtually all new issues are being offered as 144A deals. Given the equally poor liquidity in the sector for both public and private deals, issuers generally choose to garner the cost savings associated with the lower registration and reporting requirements of private deals. We expect this trend to continue unless and until the regulatory environment changes significantly.

Key Points

- Since 2008, the supply of non-agency MBS has essentially been a trickle and the market continues to languish at a fraction of the volumes attained prior to the financial crisis.
- Loans most likely to be securitized under this category are non-GSE insurable loans, such as jumbo-balance mortgages as subprime and Alt-A loans are not being originated in any significant volumes.
- The only significant source of non-agency MBS supply has been securitizations by some non-bank financial institutions, such as real estate investment trusts (REITs), in addition to periodic transactions by dealers.
- In REIT securitizations, which are collateralized by assets of very high credit quality, the subordinated risk is retained by the issuers with the pricing of the subordinated risk internal to the issuer. As such, it is difficult from the outside looking in to make an educated assessment about the economics of non-agency securitizations.
- Other lenders, such as banks, have mainly been originating such loans for portfolio purposes and not securitizing the assets.
- The reasons behind the lack of securitization activity by banks likely include higher costs of due diligence and enhanced disclosure, the regulatory uncertainty created by the lack of resolution with respect to risk retention, and capital requirements favoring whole loan retention.
- The risk retention requirements refer to the portion of risk that is required to be retained by sponsors of asset securitization, as mandated by the Dodd-Frank Act.
- The Dodd-Frank Act requires regulatory agencies to define both a Qualified Mortgage (QM) and Qualified Residential Mortgage (QRM). The former designation relates to the ability and capacity of the borrowers to repay the mortgage loan and governs primary lending. The latter refers to the type of mortgages that can be securitized without the issuing

entity retaining a portion of the credit risk of the underlying mortgages. It is only recently that rules were finalized with the regulations aligning the definition of QRM with that of QM-compliant mortgages.

- For loans which are not QRM- (and QM)-compliant, the sponsor of the securitization is required to retain a minimum of 5% of the credit risk associated with the loans. In retaining this risk, the regulations allow the sponsor of the securitization to shape the form of risk retention by either retaining a "horizontal" or "vertical" interest or retaining a combination of such interests, also referred to as an "L"-shaped interest.
- In the horizontal risk retention scheme, the sponsor is required to hold the most subordinate 5% interest, i.e., a first-loss tranche. Additionally, this scheme also requires the sponsor to disclose the fair value of the retained interests and methodology used in determining such fair value. As an alternative, the sponsor may choose to fund an account with a cash balance equal to the market value of the retained first-loss interest.
- In the vertical retention scheme, the sponsor may either retain at least 5% of each securitized class (both senior and subordinate) or a single vertical security that is comprised of 5% of each issued class.
- The vertical retention scheme is not subject to the fair-value disclosure requirements as is the case with the horizontal risk retention method. Sponsors may also combine vertical and horizontal interests to meet the 5% risk retention requirement.
- The choice of whether the risk retention is "vertical" or "horizontal" has implications for the supply of non-agency securitized MBS.
- The implementation of the horizontal model is likely to result in lower proceeds from securitization for banks, which view the securitized markets as a funding source. Under this scheme, since the sponsor of the securitization has to disclose the fair market value of the retained assets, the adoption of this scheme of risk retention will likely result in higher capital requirements for banks. As such, banks are likely to gravitate toward the vertical risk retention model.
- The motivation for regulated entities such as banks to originate non-QRM-compliant (and by definition non-QM-compliant) loans, given the potential future liability associated with the possible nonperformance of such loans, is also questionable. In the event such loans are securitized, Basel III capital regulations cap the value of mortgage servicing assets at 10% of an institution's Tier I capital, which is more stringent than the current 50% cap. In view of these rules, some banks may choose not to securitize and retain such loans as portfolio assets, as this option does not create a separate servicing asset.
- The horizontal model is likely to be used by REITs, which after the financial crisis have been one of the active users of the securitization strategy in the otherwise moribund non-agency MBS market.
- The economic model for many REITs has been to securitize mortgage production while holding the subordinated classes, which has the same effect as retaining a horizontal risk retention tranche. While these types of securitizations are likely to continue, this source of non-agency MBS supply is likely to be opportunistic, as the ability of such institutions to continue to retain subordinated risk is not unlimited.
- Given the worse than expected performance of securities rated at the higher end of the rating spectrum and the dismal performance of securities at the lower end of the rating scale, the breadth of demand as well as investor preferences for sponsor risk retention in non-agency MBS securitizations is still an unanswered question.

- Investors that seek active participation in this market are likely to demand enhanced reps and warranties to ease fraud and put-back resolution, a stronger role accorded to the trustee in the management of the Pooling and Servicing Agreement (PSA), a higher degree of granular performance data over the life of the deal, and more accessible sources of such data.
- In order to maintain credibility and fend off criticism, it is not unreasonable to conclude that rating agencies may determine subordination levels which are onerous enough to negatively affect the economics of securitization. Alternatively, investors in subordinate securities may view the subordination levels as not onerous enough to cushion extreme-case housing price shocks.
- In view of these circumstances, banks may resort to selling production as whole loans and/or originate loans only for investment purposes. Asset securitization may only be used by originators, such as REITs, that cannot either hold loans in portfolio or do not have access to cheaper alternative funding sources.
- Assuming that progress can be made with respect to investor demands such as enhanced reps and warranties and standardization of pooling and servicing agreements, we envision a non-agency market with much lower volumes, comprised of private deals and dominated mainly by REITs, with the majority of the subordinated credit risk retained by the issuer.

CHAPTER 28

RESIDENTIAL MORTGAGE DEFAULTS, FORECLOSURES, AND MODIFICATIONS

FATEN SABRY, IGNACIO FRANCESCHELLI, AND DREW CLAXTON

AFTER reading this chapter you will understand:

- trends in mortgage delinquencies and foreclosures underlying MBS;
- trends in housing prices, mortgage rates, gross equity extraction, debt service ratios, and unemployment;
- evolution of the literature on determinants of mortgage default, including econometric models used by academics and the industry;
- loss mitigation methods, foreclosure rules, and modification programs; and
- impact of the modification programs: trends in loan modifications and re-default rates.

Several factors converged in 2007 to precipitate the worst financial crisis since the Great Depression. US housing prices that rose to unprecedented rates through 2006 stopped rising and started to fall. Interest rates continued to increase, and unemployment rates began to rise. Households, having increased their spending during the boom years, found themselves highly leveraged by the onset of the housing bust. The rate of delinquencies and defaults for all types of mortgages—including prime, Alt A, and subprime—rose beyond historical rates, and the private-label mortgage-backed securities ("MBS") market collapsed. By the end of 2014, approximately 5.4 million US households owed more on their homes than their homes were worth, more than 700 thousand borrowers were seriously delinquent on their loans, and several million homes had gone into foreclosure. In this chapter, we review several factors that impact mortgage default behavior; the expansive literature on the determinants of mortgage default, before and after the credit crisis; and the private and governmental responses to the crisis, such as loan modification programs for distressed borrowers and lenders. The effectiveness and social costs of such programs and their impact on changing a borrower's default behavior will continue to be controversial issues among academics and market participants.

Trends in Delinquencies, Defaults, and Foreclosures by Mortgage Product and Vintage over Time

In the years leading up to the mortgage market crisis, there was a dramatic increase in mortgage originations and the securitization of mortgage loans. Between 2000 and 2003, there was a 400% increase in the value of mortgages securitized. In 2000, $1.05 trillion in mortgage loans were originated and $527 billion in mortgages were securitized. The volume of loans originated and securitized peaked in 2003, with $3.95 trillion originated and $2.66 trillion securitized. In 2008, loan originations dropped to $1.5 trillion, and the dollar value of mortgages securitized had dropped to $1.18 trillion, a 56% drop from 2003.

The volume of subprime mortgage loans that were originated and securitized surged between 2000 and 2005. In 2000, $100 billion in subprime mortgage loans were originated and $52 billion in subprime MBS were issued. In 2005, the volume of subprime origination peaked at $625 billion, and $465 billion in subprime mortgage loans were securitized, an increase of 786% compared to the volume securitized in 2000. Subprime loan origination and securitization dropped in 2008, with $2.26 billion in subprime mortgage loans securitized, an almost 100% drop in the dollar value from its peak in 2005.

Trends in Mortgage Delinquency, Default, Foreclosure, and Liquidations

Mortgage delinquency occurs when a borrower fails to make his/her scheduled payments. Most of the literature would define serious delinquency, or default, as loans that are 60 to 90 days past due or more. If a borrower is unable to cure the default, that is, to become current on their mortgage again, the lender and borrower can agree to modify the terms of the loan contract, to liquidate the mortgage through a short sale or a deed-in-lieu transfer, or the bank can foreclose on the mortgage. If the mortgage is foreclosed on, the bank attempts to sell the property at a foreclosure auction and those properties that are unable to be sold become real estate owned (or "REO") by the bank. Throughout the 1990s and early 2000s, the percent of residential mortgages in default ranged between 1.4% and 3.4% based on the Federal Reserve charge-off and delinquency rates.

Subprime Defaults and Foreclosures

Figure 28.1 presents data on subprime collateral delinquency and foreclosure rates. As presented in the figure, from 2005 to 2006 the percent of subprime mortgages in default increased by 15%, from 5.1% to 5.86%.[1] By 2007, the percent of subprime loans in default had increased by another 55%. The percent of subprime loans in default continued to increase, peaking in early 2010 at 19.09%. By the end of 2014, the percent of subprime loans in default had decreased but had not fallen back to pre-crisis levels.

The percent of subprime mortgages in foreclosure increased by 36% between 2005 and 2006, and by another 91% by 2007. By 2009, 15.58% of subprime mortgages were in foreclosure, and the percent of mortgages in foreclosure fluctuated between 14% and 15% for the next two years. By the end of 2014, 9.63% of subprime loans were in foreclosure.

Prime Defaults and Foreclosures

Figure 28.2 presents data on prime collateral delinquencies and foreclosures. In 2006 the percent of prime mortgages in default began to increase. The percent of prime mortgages in default increased by 68%, from 0.75% in 2006 to 1.26% in 2007. By 2008, the percent of prime loans in default had increased by another 114% and increased again by

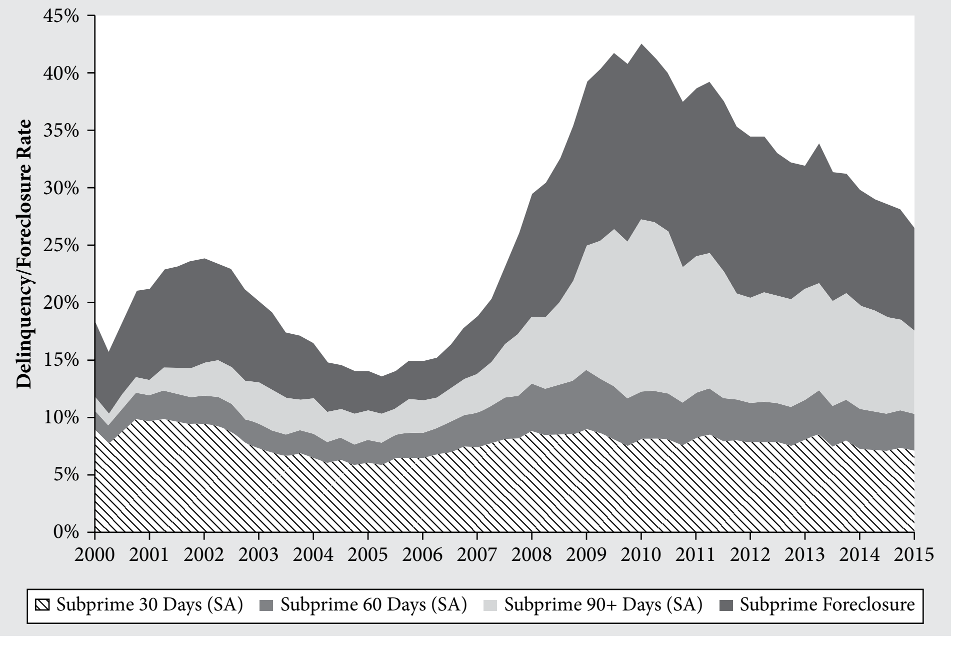

FIGURE 28.1 Subprime collateral delinquency and foreclosure rates

Source: Data are based on conventional loans and obtained from Mortgage Bankers Association. Delinquency rates are seasonally adjusted (SA) and foreclosures are not seasonally adjusted.

[1] For Figures 28.1 and 28.2, mortgage default is defined as a loan being 60 days or 90+ days delinquent. Foreclosure is analyzed separately.

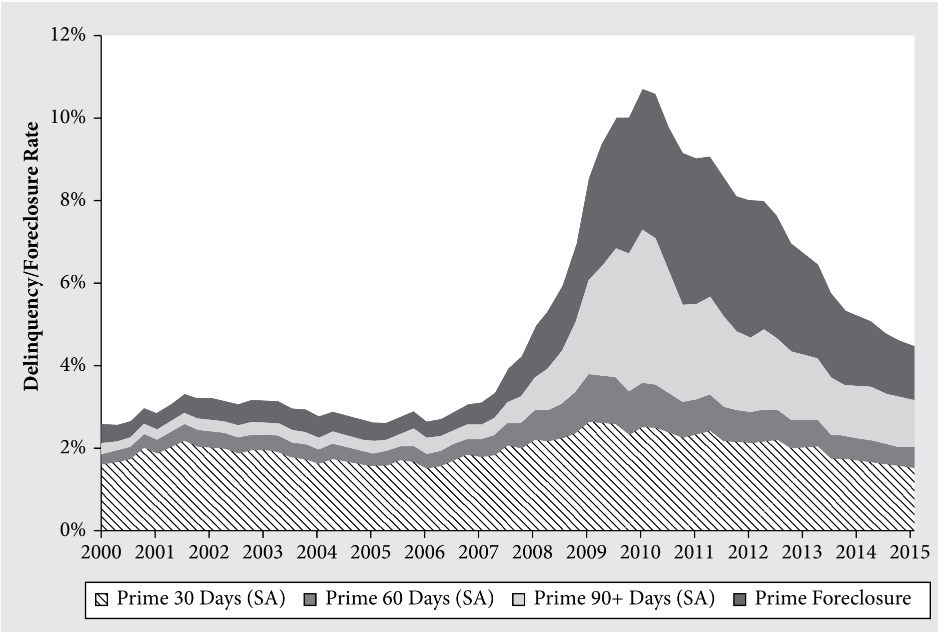

FIGURE 28.2 Prime collateral delinquency and foreclosure rates

Source: Data are based on conventional loans and obtained from Mortgage Bankers Association. Delinquency rates are seasonally adjusted (SA) and foreclosures are not seasonally adjusted.

63% in 2009. The percent of prime loans in default peaked in 2010 at 4.81%. By the end of 2014, the percent of prime loans in default had decreased to 1.71% but was more than twice the percent in 2005 (0.81%).

From 2005 to 2006, the percent of prime mortgages in foreclosure increased by 19% (as compared to 36% for subprime mortgages during the same period). Between 2006 and 2007, the percent of prime mortgages in foreclosure increased again by 92%, and again by 96% by 2008. The percent of prime mortgages in foreclosure peaked at 3.67% in late 2010.

Macroeconomic Trends Before and After the Financial Crisis

Changes in housing prices, interest rates, unemployment, and liquidity are all factors that academics and industry analysts have often examined when analyzing mortgage defaults. Changes in housing prices would directly affect the amount of equity one has in their home. As housing prices decrease, the value of the borrower's home decreases, as does their equity position. Changes in interest rates may affect the payment-to-income ratio for borrowers with adjustable-rate loans, as well as their refinance opportunities. Finally, loss of income through unemployment (and also through divorce or death), as well as other liquidity constraints, would also affect a borrower's ability to pay the mortgage payment due.

Trends in Housing Prices and Interest Rates

Figure 28.3 presents data on housing prices and the Freddie Mac effective 30-year fixed mortgage rate from 2000 to 2014. The change in the Federal Housing Finance Agency (FHFA) Housing Price Index (HPI) over 12 months rose from approximately 6.7% in 2000 to approximately 10.4% in 2005. The 30-year fixed mortgage rate averaged around 8.1% in 2000 and 5.9% in 2005. However, in 2006 the change in the FHFA HPI dropped precipitously, landing at –10.4% by the end of 2008. Between 2005 and 2008, the cost of credit also increased.

Trends in Equity Extraction

Between 2000 and 2005, homeowners had the opportunity to convert the equity in their homes into cash through the low cost of refinancing. As Figure 28.4 shows, homeowners borrowed against the equity in their homes at unprecedented rates during this period of time. While home equity extraction remained stable throughout most of the 1990s, averaging around $130 billion extracted per year, it grew to $303 billion by 2000. By 2005, gross equity extraction had increased by 200%, reaching $914 billion extracted per year.

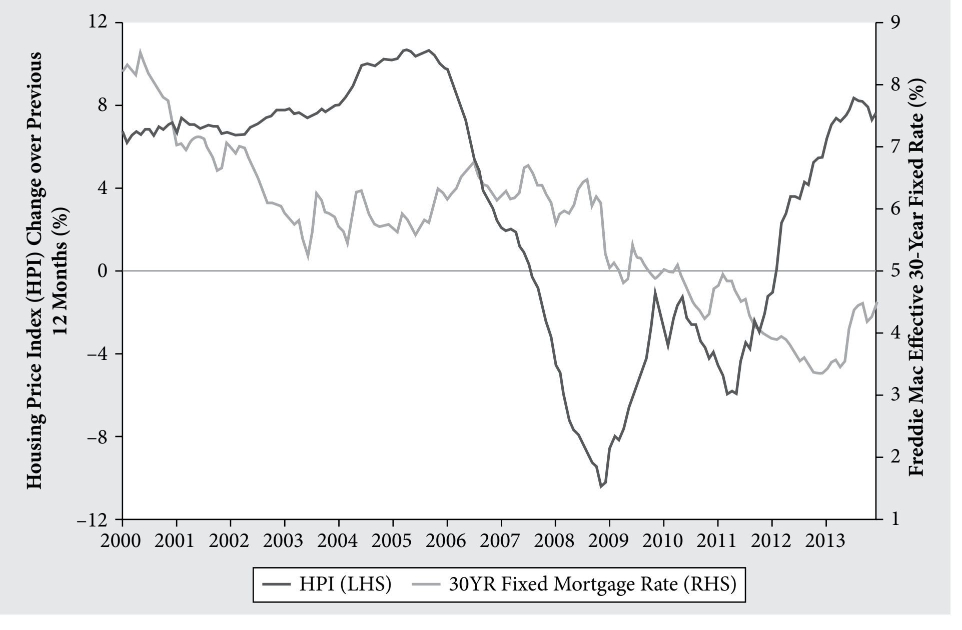

FIGURE 28.3 Trend in Housing Price Index (HPI) and cost of credit

Source: FHFA and Freddie Mac

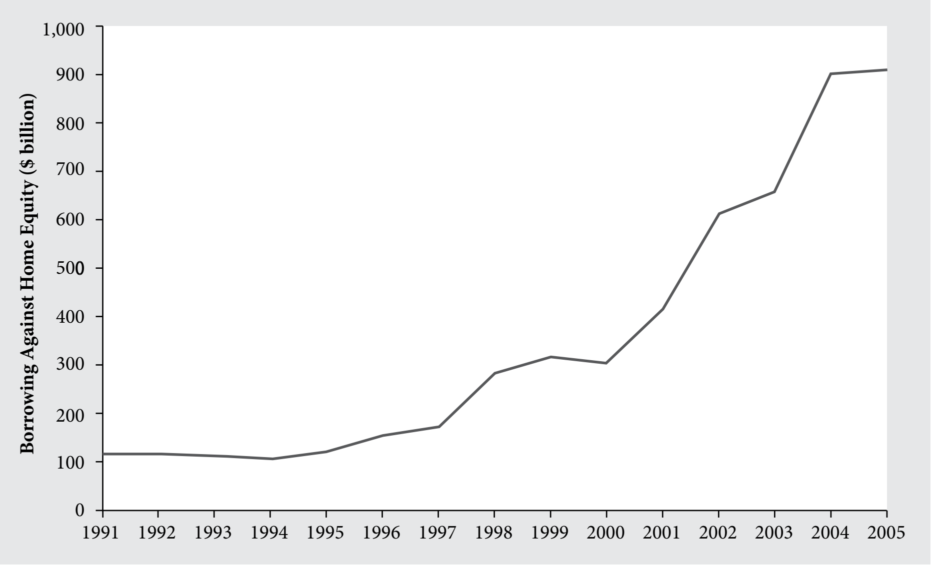

FIGURE 28.4 Gross equity extraction increased significantly since 2000

Source: Alan Greenspan and James Kennedy, "Sources and Uses of Equity Extracted from Homes," Finance and Economics Discussion Series, Federal Reserve Board (2007)

Trends in Leveraged Debt

Another sign of liquidity constraint is the household debt service ratio, measured as the ratio of debt payments to disposable personal income. As shown in Figure 28.5, the seasonally adjusted total debt service ratio was 10.37% in the second quarter of 1993 and peaked at 13.17% by the end of 2007.[2] The period after 2007 saw a marked drop in the debt service ratio, reaching its lowest point, 9.83%, in the fourth quarter of 2012.

Trends in Unemployment

Income shocks, often measured by the unemployment rate, can affect a borrower's ability to pay their mortgage payment. Figure 28.6 presents data on unemployment rates from 2000 to 2014. Between 2000 and 2014 the unemployment rate spiked twice, first in 2001 and second in 2007. In 2001 it increased by 36% from 4.2% to 5.7% and peaked at 6.3% in 2003. By the start of 2007 it had fallen to 4.5%, but again began to rise. By December 2007, the unemployment rate was 5%, and by October 2009 it had doubled to 10%. It has steadily decreased since then at a rate of about 0.8 percentage points per year, but has not returned to 2007 levels.

[2] The total debt servicing ratio is defined as the sum of the required mortgage payments and the scheduled consumer debt payments divided by the disposable personal income.

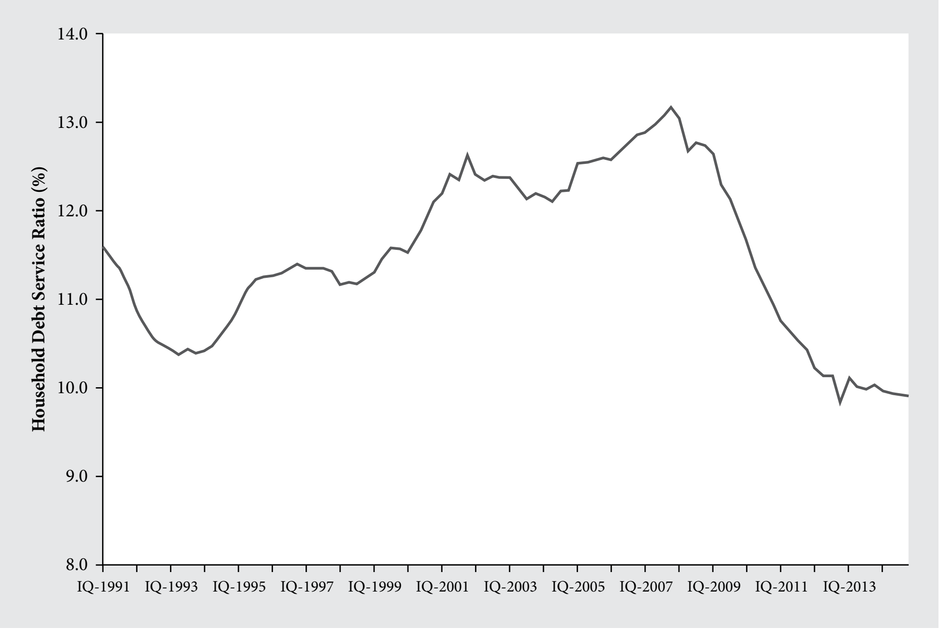

FIGURE 28.5 Household debt service ratio

Source: Federal Reserve

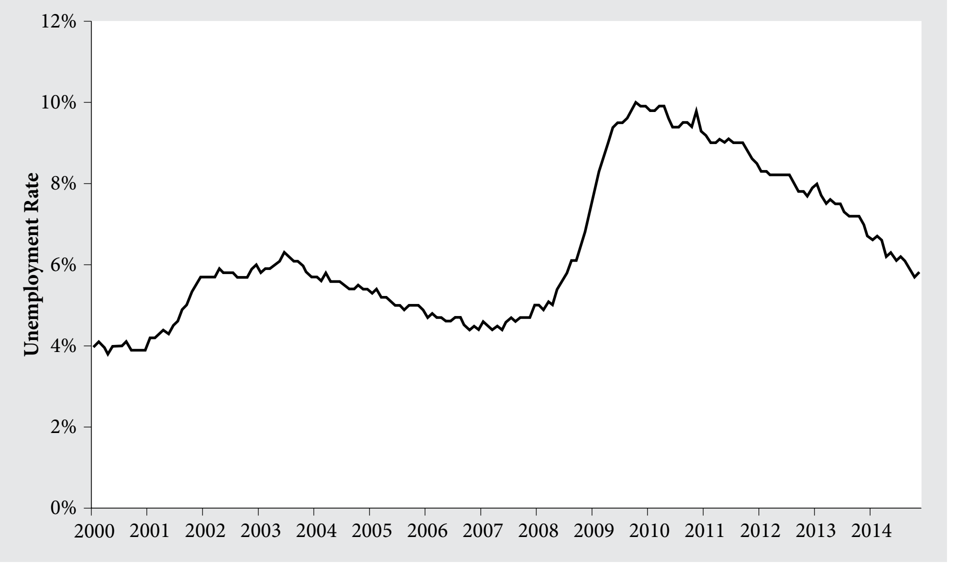

FIGURE 28.6 Unemployment rate

Source: Unemployment data are from the Bureau of Labor Statistics and are seasonally adjusted.

The impact of income and employment loss on mortgage defaults during this period was captured by the FHA in a survey that it conducted of its loan servicers. The survey found that income or unemployment was a primary reason for borrowers to be 90 days or more delinquent on their FHA mortgages.[3] The survey results show that the number of new FHA loans that became 90 days delinquent increased almost 250% between 2007 and the end of 2009, growing from around 44,000 to more than 152,000. In 2007, 26.4% of new 90-day delinquencies reported income or unemployment as the principal reason for default. By 2010, nearly 50% of new 90-day delinquencies reported income or unemployment as the principal reason for default. Table 28.1 reports the results of the FHA survey.

Table 28.1 New 90-day delinquencies with principal reason

		Shares by Principal Reason[1]			
Year and Quarter	New 90-Day Delinquency	Income or Unemployment	Excessive Obligations	Other Reasons[2]	No Contact
(1)	(2)	(3)	(4)	(5)	(6)
2007Q1	44,258	26.4%	28.3%	32.6%	12.7%
2007Q2	46,991	27.1	29.2	31.1	12.7
2007Q3	62,802	28.1	27.2	31.5	13.2
2007Q4	78,642	30.5	25.7	30.0	13.7
2008Q1	67,557	32.2	25.3	28.9	13.6
2008Q2	67,928	34.1	22.9	29.2	13.9
2008Q3	92,035	36.0	22.0	27.8	14.3
2008Q4	122,367	39.4	19.5	26.8	14.3
2009Q1	111,449	43.7	17.1	25.4	13.9
2009Q2	108,000	46.7	15.3	24.8	13.1
2009Q3	146,712	47.5	14.6	24.8	13.0
2009Q4	152,884	48.8	14.5	23.8	13.0
2010Q1	124,579	48.5	14.7	22.7	14.1
2010Q2	104,107	48.6	15.6	21.1	14.7
2010Q3	131,030	49.0	16.3	21.4	13.3
2010Q4	133,718	48.9	16.7	21.4	12.9
2011Q1	117,917	48.9	16.7	22.3	12.1
2011Q2	99,260	48.5	17.6	22.8	11.1
2011Q3	133,838	46.9	18.9	22.6	11.6

Notes: [1] As reported by delinquent homeowners to their loan servicers.
[2] Principal reasons in the Other category are death or illness and marital problems.

Source: US Department of Housing and Urban Development, "Annual Report to Congress Regarding the Financial Status of the FHA Mutual Mortgage Insurance Fund" (November 15, 2011)

[3] US Department of Housing and Urban Development, "Annual Report to Congress Fiscal Year 2011: Financial Status—FHA Mutual Mortgage Insurance Fund" (November 2011). Available at <http://portal.hud.gov/hudportal/documents/huddoc?id=fhammifannrptfy2011.pdf>.

Academic Analysis of Mortgage Defaults

For the past 50 years, academics have studied mortgage default as a key metric in assessing residential mortgage risk. The relative importance of loan and borrower characteristics, macroeconomic conditions, transaction costs, and other factors on the probability of mortgage default continues to be debated.

Early Academic Literature

Central to the studies conducted from 1960 to 1992 was "a desire to minimize the default costs to both borrowers and lenders."[4] Mortgage defaults cost the lender a portion of the value of the financial asset and cost the borrower a loss in creditworthiness, future opportunities to own a home, and, potentially, access to employment opportunities.

The early literature on mortgage defaults attempted to identify the loan and borrower characteristics that were correlated with either the change in mortgage interest rates as a measure of risk,[5] mortgage risk premiums,[6] or mortgage defaults directly.[7] The studies of mortgage risk accounted for loan and borrower characteristics, such as: the loan-to-value ratio (LTV) or home equity (1-LTV), initial mortgage rate and mortgage term, borrower's income and loan size, as reported at loan origination; the age of the mortgage (and in some cases, age squared); the presence of junior financing; various measures of liquidity, such as the debt-to-equity ratio, payment-to-income ratio, and non-real estate debt; and proxies for income stability, such as whether the borrower was in a professional occupation, self-employed, a salesman, or was unskilled labor, the number of years with an employer, and the unemployment rate. In addition, some studies included demographic information on the borrower's marital status and number of dependants, and the initial condition of the neighborhood in which the property was located.

[4] For a thorough review of the early literature, see Robert G. Quercia and Michael A. Stegman, "Residential Mortgage Default: A Review of the Literature," *Journal of Housing Research* 3/2 (1992), 341–79.

[5] Alfred N. Page, "The Variation of Mortgage Interest Rates," *Journal of Business* 37/3 (July 1964), 280–94.

[6] Richard L. Sandor and Howard B. Sosin, "The Determinants of Mortgage Risk Premium: A Case Study of the Portfolio of a Savings and Loan Association," *Journal of Business* 48/1 (January 1975), 27–38.

[7] See George M. von Furstenberg, "Default Risk on FHA-Insured Home Mortgages as a Function of the Terms of Financing: A Quantitative Analysis," *Journal of Finance* 24/3 (June 1969), 459–77; George M. von Furstenberg, "Interstate Differences in Mortgage Lending Risks: An Analysis of Cause," *Journal of Financial and Quantitative Analysis* 5 (1970), 229–42; George M. von Furstenberg, "The Investment Quality of Home Mortgages," *Journal of Risk and Insurance* 37/3 (September 1970), 437–45; John P. Herzog and James S. Earley, *Home Mortgage Delinquency and Foreclosure* (New York: National Bureau of Economic Research, 1970); Alex O. Williams, William Beranek, and James Kenkel, "Default Risk in Urban Mortgages: A Pittsburgh Prototype Analysis," *Real Estate Economics* 2/2 (June 1974), 101–12; and Gregory T. Morton, "A Discriminant Function Analysis of Residential Mortgage Delinquency and Foreclosure," *Real Estate Economics* 3/1 (March 1975), 73–88.

The proxies used to measure income stability consistently had a significant effect. The less stable the borrower's income was expected to be, the higher the credit risk. In addition, the LTV or the equity position at origination was found to have a significant impact on mortgage defaults.[8]

The Introduction of Time into Default Models

Vandell explicitly analyzed the change in borrower characteristics over time by assessing the importance of four sets of explanatory variables on mortgage default.[9] These variables included: "borrower-related effects" (borrower income at a given point in time), the "payment burden" (the fraction of income used to pay the mortgage at a given time), equity accumulation (including original equity, equity accumulated through mortgage amortization, and equity acquired through property appreciation at a given point in time), and a transient time term (a proxy for the increased initial borrower effort to make mortgage payments). Vandell found that, while a reduction in income or income expectations increased default risk, the increase was moderate and the predicted risk was within an acceptable range. However, contemporaneous net equity was important in predicting default risk for fixed-rate mortgages and more so in predicting the default risk for alternate mortgage products, such as the price-level-adjusted mortgages (PLAM) and graduated-payment mortgages (GPM). Campbell and Dietrich found that the default experience of the 1960s and 1970s was significantly influenced by changes in regional unemployment rates. Like Vandell, they also found that current LTV had a significant impact on mortgage default, "implying that mortgages having a large potential for negative amortization also have substantial risk."[10]

Competing Theories of Mortgage Default

Implicit in the early studies of mortgage default were two competing views of mortgage default—the equity maximization theory of default and the ability-to-pay theory of default—formalized by Jackson and Kaserman.[11] Households were expected to maximize their utility and net wealth by rationally deciding whether to continue to pay or

[8] Quercia and Stegman also noted that the earliest studies of the determinants of mortgage defaults were undertaken by government agencies in charge of regulating the home financing system (see for example, US Federal Housing Administration's "FHA Experience with Mortgage Foreclosures and Property Acquisitions," 1962). These studies described the relation between delinquency and loan-to-value ratios, housing expense-to-income ratios, and the borrower's occupational skill level, among other variables. However, the results were mostly descriptive and the statistical significance of the findings was not assessed. Quercia and Stegman, "Residential Mortgage Default: A Review of the Literature."

[9] Kerry D. Vandell, "Default Risk Under Alternative Mortgage Instruments," *Journal of Finance* 33/5 (December 1978), 1279–96.

[10] Tim S. Campbell and J. Kimball Dietrich, "The Determinants of Default on Insured Conventional Residential Mortgage Loans," *Journal of Finance* 38/5 (December 1983), 1569–81. They cautioned, however, that their findings should not be used to project future default incidence for alternative mortgages as the variation in the LTV and payment-to-income ratio were too small during the sample period to provide an adequate estimation of the determinants of historical default rates.

[11] Jerry R. Jackson and David L. Kaserman, "Default Risk on Home Mortgage Loans: A Test of Competing Hypotheses," *Journal of Risk and Insurance* 47 (December 1980), 678–90.

to default on their mortgage.[12] A borrower's default behavior was viewed as either "ruthless"[13]—where the borrower walked away from their mortgage when the value of their home was less than the amount of their loan, regardless of transaction costs, borrower characteristics, or other factors—or as "double triggered,"[14] where the borrower walked away only when they had reached a certain threshold of negative home equity as well as a negative income shock. While considered "competing theories" by Jackson and Kaserman, Clauretie and Herzog argued that there was no inherent conflict between the two:

> If the mortgagor has a default option that is "in-the-money," in the sense that there is negative equity in the property, he may choose not to exercise the option if his combined consumer surplus in the present residence and the cost of default (such as a bad credit rating) exceed the value of the option. If an event such as divorce or unemployment occurs, an early exercise of the option becomes optimal. The loss of the residence and the bad credit rating become inevitable.[15]

Equity Theory of Mortgage Default

The equity maximization theory, nested in the framework of options theory, considers residential mortgages to be debt instruments for which mortgage default is a put option.[16] A borrower exercises the put when the option is "in the money"—when the borrower experiences negative home equity. The put option allows the borrower to sell the house to the lender for the value of the mortgage at the beginning of each payment period, thereby eliminating their negative equity position and maximizing their financial welfare.

[12] Chester Foster and Robert Van Order, "An Option-Based Model of Mortgage Default," *Housing Finance Review* 3 (1984), 351–72; James F. Epperson, James B. Kau, Donald C. Keenan, and Walter J. Muller, III, "Pricing Default Risk in Mortgages," *Real Estate Economics* 13 (September 1985), 261–72; Kerry D. Vandell and Thomas Thibodeau, "Estimation of Mortgage Defaults Using Disaggregate Loan History Data," *Journal of the American Real Estate and Urban Economics Association* 13/3 (1985), 292–316, and John M. Quigley and Robert Van Order, "Defaults on Mortgage Obligations and Capital Requirements for U.S. Savings Institutions: A Policy Perspective," *Journal of Public Economics* 44/3 (1991), 353–69.

[13] James B. Kau, Donald C. Keenan, and Taewon Kim, "Default Probabilities for Mortgages," *Journal of Urban Economics* 35/3 (1994), 278–96.

[14] Kerry D. Vandell, "How Ruthless Is Mortgage Default? A Review and Synthesis of the Evidence," *Journal of Housing Research* 6/2 (1995), 245–64; Jackson and Kaserman, "Default Risk on Home Mortgage Loans: A Test of Competing Hypotheses." Jackson and Kaserman formalized the two theories of mortgage default and tested whether the equity position or the payment-to-income ratio was more important in predicting default rates. They found that the equity position had a greater impact than the ability to pay.

[15] Terrence M. Clauretie and Thomas Herzog, "The Effect of State Foreclosure Laws on Loan Losses: Evidence from the Mortgage Insurance Industry," *Journal of Money, Credit and Banking* 22/2 (May 1990), 221–33.

[16] Foster and Van Order, "An Option-Based Model of Mortgage Default"; Epperson, Kau, Keenan, and Muller, III, "Pricing Default Risk in Mortgages"; Vandell and Thibodeau, "Estimation of Mortgage Defaults Using Disaggregate Loan History Data"; Quigley and Van Order, "Defaults on Mortgage Obligations and Capital Requirements for U.S. Savings Institutions: A Policy Perspective."

In its strictest form, the equity maximization theory asserts that a borrower's default behavior is both strategic and "ruthless"—where the borrower walks away from their mortgage when the value of their home is less than the amount of their loan, regardless of transaction costs, borrower characteristics, or other factors.[17]

Probability of Default = Probability (Equity < Mortgage Balance)

However, while the equity maximization theory works well to explain the exercise of the default option, empirical evidence has shown that households do not exercise the option as ruthlessly as the theory might suggest. For example, Foster and Van Order estimated an option-based model of default and found that even when equity was quite negative the probability of default was less than 10%.[18]

To reconcile the disconnect between theory and empirical findings, Quigley and Van Order argued that transaction costs and capital constraints made the exercise of the option less ruthless; Kau, Keenan, and Kim explicitly showed that the value of defaulting in the future could be sufficient to cause a borrower to forgo or postpone exercising their default option even in the face of a negative equity position; and Vandell and Thibodeau used a formal model of consumer choice that did not automatically assume that current equity was the relevant criterion affecting default but, rather, provided for maximizing expected terminal wealth.[19] Their model showed that borrowers compared their expected equity plus wealth from other sources to their expected total wealth if they chose to default. By doing so, the importance of transaction costs and opportunity costs in the housing market, and of other investment alternatives, on a borrower's decision to default became explicit.

Further, Clauretie argued that the option models had specifically ignored the role of the lender in the default–foreclosure process and, in so doing, had ignored transaction costs, particularly the legal costs of foreclosure to both the lender and the borrower.[20] Lenders had more incentive to foreclose if current interest rates were higher than the contract rate, and they had more incentive to renegotiate the terms of the contract where legal costs of foreclosure were high. In states where deficiency judgments were practiced—where the borrower would be financially responsible for any shortfall between the loan balance and the revenue generated from the sale of their foreclosed property—negative equity was not sufficient to explain default. Using survey data on

[17] Yongheng Deng, John M. Quigley, and Robert Van Order, "Mortgage Terminations, Heterogeneity and the Exercise of Mortgage Options," *Econometrica* 68/2 (March 2000), 275–307; Jerry R. Jackson and David L. Kaserman, "Default Risk on Home Mortgage Loans: A Test of Competing Hypotheses," *Journal of Risk and Insurance* 47/4 (1980), 678–90; and James B. Kau, Donald C. Keenan, and Taewon Kim, "Default Probabilities for Mortgages," *Journal of Urban Economics* 35/3 (1994), 278–96.

[18] Foster and Van Order, "An Option-Based Model of Mortgage Default."

[19] John M. Quigley and Robert Van Order, "More on the Efficiency of the Market for Single Family Homes: Default," Center for Real Estate and Urban Economics Working Paper No. 92-210 (1992); Vandell and Thibodeau, "Estimation of Mortgage Defaults Using Disaggregate Loan History Data"; and Kau, Keenan, and Kim, "Default Probabilities for Mortgages."

[20] Terrence M. Clauretie, "The Impact of Interstate Foreclosure Cost Differences and the Value of Mortgages on Default Rates," *Journal of the American Real Estate and Urban Economics Association* 15/3 (1987), 152–87.

semiannual foreclosure rates (1976–80) by state, Clauretie found that both the value of the mortgage and the legal cost of foreclosure to the bank had a significant impact on the foreclosure rate, with the method of foreclosure (judiciary or nonjudiciary) and the length of statutory redemption period being statistically significant. Ambrose, Buttimer, and Capone further showed that the length of time between default and foreclosure mattered, as borrowers could accrue the benefit of "free rent" in the interim.[21] They concluded that a lender's ability to impose transaction costs on a borrower in default could dramatically reduce the probability of a complete exercise of the foreclosure put option.

Ability-to-Pay Theory of Mortgage Default

The ability-to-pay theory asserts that a borrower will continue to pay their mortgage, despite their equity position, as long as they have the income to do so. A borrower walks away from their mortgage only when they have experienced a certain threshold of negative home equity as well as a negative income shock.

Probability of Default = Probability (Income < Principal + Interest Payment)

Studies analyzing the importance of "trigger events" such as job loss, divorce, death, or job relocation have found mixed results. Campbell and Dietrich found unemployment to be one of the most important factors in explaining mortgage default; Clauretie found unemployment to be significant in some models and not others; Thomson found unemployment to be a significant determinant of default behavior, although he noted that it had a relatively modest impact; and Foster and Van Order, and Quigley, Van Order, and Deng found that unemployment provided little to no explanatory power.[22] Hendershott and Schultz focused on the sharp increase in mortgage defaults in the 1980s and found that home equity and unemployment were significant determinants of mortgage default. They also found that as the book value of equity (the amount that the sellers would receive if they sold their home without defaulting) went down, the importance of unemployment went up.[23] Capozza, Kazarian, and Thomson included in their model the unemployment rate by metropolitan statistical area (MSA), the divorce rate in each MSA, and the proportion of people who changed residence during the 1975–80 periods as reported by Census as well as LTV.[24] They found that trigger effects such as

[21] Brent W. Ambrose, Richard J. Buttimer, Jr., and Charles A. Capone, "Pricing Mortgage Default and Foreclosure Delay," *Journal of Money, Credit and Banking* 29/3 (1997), 314–25.

[22] Campbell and Dietrich, "The Determinants of Default on Insured Conventional Residential Mortgage Loans"; Clauretie, "The Impact of Interstate Foreclosure Cost Differences and the Value of Mortgages on Default Rates"; Thomas A. Thomson, "A Metropolitan Analysis of Mortgage Loan Defaults," *Journal of Finance* 49/3 (1994), 1097–8; Foster and Van Order, "An Option-Based Model of Mortgage Default"; and John M. Quigley, Robert Van Order, and Yongheng Deng, "The Competing Risks for Mortgage Termination by Default and Prepayment: A Minimum Distance Estimator," National Bureau of Economic Research Working Paper (1994).

[23] Patric H. Hendershott and William R. Schultz, "Equity and Nonequity Determinants of FHA Single-Family Mortgage Foreclosures in the 1980s," *Real Estate Economics* 21/4 (December 1993), 405–30.

[24] Dennis R. Capozza, Dick Kazarian, and Thomas A. Thomson, "Mortgage Default in Local Markets," *Real Estate Economics* 25/4 (1997), 631–55.

unemployment and divorce had statistically significant impacts on defaults, although to a lesser degree than other factors.

Default Studies after the Credit Crisis

Since the credit crisis, the academic literature has focused on determining the factors that contributed most to the unprecedented increase in mortgage defaults. Research has focused on whether securitization led to weak underwriting standards; whether expansion in underwriting standards, if found, significantly affected loan performance; or whether macroeconomic conditions—in particular, the steep decline in housing prices and the dramatic increase in unemployment—were at the root of the mortgage market crisis. The findings of the studies are mixed, and research in this area remains ongoing.

The Role of Moral Hazards

Keys, Mukherjee, Seru, and Vig found that low documentation loans for subprime securitized mortgages with a credit score above the 620 threshold (considered to be less risky), defaulted within two years at a much higher rate (10%–25%) than the mean default rate of 5%. Having accounted for observable loan and borrower characteristics, they inferred that "the only remaining difference between the loans around the [credit score] threshold is the increased ease of securitization. Therefore, the greater default probability of loans above the credit threshold must be due to a reduction in screening by lenders."[25]

However, Kaufman and Bubb reexamined the evidence used in the study by Keys, Mukherjee, Seru, and Vig regarding credit score cutoff rules and found that "it has been misinterpreted."[26] Using both loans that were securitized and loans that remained in the banks' portfolios, they too found that there were discontinuities around the credit score (FICO 620) threshold, but documented that the default rate jumped at the threshold even for samples of loans where there was no jump in securitization. They concluded that instead of showing that securitization led to moral hazard, the cutoff rule provided evidence of the opposing hypothesis: "securitizers were to a significant extent able to regulate lender's underwriting behavior." Securitizers were aware of and attempted to mitigate the moral hazard posed by securitization.

Bhardwaj and Sengupta stressed the multidimensional nature of credit risk and showed that, while underwriting may have been relaxed along some dimensions (such as lower documentation levels), it was strengthened along others (such as higher credit

[25] Benjamin J. Keys, Tanmoy Mukherjee, Amit Seru, and Vikrant Vig, "Did Securitization Lead to Lax Screening? Evidence from Subprime Loans," *EFA 2008 Athens Meetings Paper* (2008), 3.

[26] Ryan Bubb and Alex Kaufman, "Securitization and Moral Hazard: Evidence from Credit Score Cutoff Rules," *Journal of Monetary Economics* 63 (2014), 1–18. See also Ryan Bubb and Alex Kaufman, "Securitization and Moral Hazard: Evidence from Credit Score Cutoff Rules," Federal Reserve Bank of Boston, Public Policy Discussion Papers No. 09-5 (August 2011).

scores).[27] Their empirical study, using loan-level data, concluded that there was no evidence of a marked decline in subprime underwriting standards post-2004, so the expansion of underwriting standards could not be the reason for the collapse in the subprime mortgage market.

Kau, Keenan, Lyubimov, and Slawson also found that the large rise in defaults of nonprime loans that started in 2007 could not be attributed to any surprise other than the unexpected and substantial fall in house prices.[28] By analyzing the characteristics and performance of privately securitized nonprime adjustable-rate mortgages originated between 1997 and 2008, the authors found that the secondary market had become aware of the change in the inherent nature of borrowers starting in late 2004 and had efficiently incorporated the available information. These findings are consistent with information that was publicly available at the time and was reported on the expansion of underwriting practices.[29]

Demyanyk and Von Hemert measured the quality of subprime mortgage loans while accounting for differences in loan and borrower characteristics, macroeconomic factors, and vintage (year of loan origination). They found that house price appreciation was the only variable in their model that contributed substantially to explaining the surge in defaults, although the effect was quantitatively too small to explain the poor performance of 2006 and 2007 vintage loans.[30] The authors concluded that "the rise and fall of the subprime mortgage market follows a classic lending boom–bust scenario, in which unsustainable growth leads to the collapse of the market."

Both Dell'Ariccia, Igan, and Laeven, and Purnanandam examined the impact of lending standards and securitization, although neither controlled for the credit characteristics of the borrower, such as credit scores.[31]

Finally, Capozza and Van Order used loan-level data on privately securitized mortgages to decompose the factors that led to the increase in defaults.[32] They found that most of the variation was due to economic conditions, such as changes in housing prices, that none was due to observable underwriting changes, and that relatively little was due to unobserved loan and borrower characteristics (e.g., moral hazard).

[27] Geetesh Bhardwaj and Rajdeep Sengupta, "Where's the Smoking Gun? A Study of Underwriting Standards for U.S. Subprime Mortgages," Federal Reserve Bank of St. Louis Working Paper (2009).

[28] James B. Kau, Donald C. Keenan, Constantine Lyubimov, and V. Carlos Slawson, "Subprime Mortgage Default," *Journal of Urban Economics* 70/2–3 (September–November 2011), 75–87.

[29] Office of the Comptroller of Currency Survey of Credit Underwriting Practices Reports for 1999–2010.

[30] Yuliya Demyanyk and Otto Van Hemert, "Understanding the Subprime Mortgage Crisis," *Review of Financial Studies* 24/6 (2011), 1848–80.

[31] Giovanni Dell'Ariccia, Deniz Igan, and Luc Laeven, "Credit Booms and Lending Standards: Evidence from the Subprime Mortgage Market," IMF Working Paper (2008); Amiyatosh Purnanandam, "Originate-to-Distribute Model and the Subprime Mortgage Crisis," *Review of Financial Studies* 24/6 (2011), 1881–1915.

[32] Dennis R. Capozza and Robert Van Order, "The Great Surge in Mortgage Defaults 2006–2009: The Comparative Roles of Economic Conditions, Underwriting and Moral Hazard," *Journal of Housing Economics* 20/2 (2011), 141–51.

The Role of Macroeconomic Factors

Many academics identified macroeconomic factors, particularly the steep decline in housing prices coupled with unemployment, income, and liquidity shocks as the primary determinants of mortgage defaults during the mortgage market crisis. Which factors were determined to be more important in the borrower's decision to default varied.[33] For example, Goodman, Ashworth, Landy, and Yin found that negative equity shocks had a greater impact on mortgage defaults than unemployment.[34] Meanwhile, Gyourko and Tracy concluded that unemployment shocks, if measured correctly, could have a greater impact on mortgage defaults than negative equity.[35]

Housing Prices Matter

Numerous studies found that the sharp decline in housing prices was the primary cause of the crisis in the mortgage market.

Bajari, Chu, and Park found negative equity to be one of the primary determinants of the increase in mortgage defaults.[36] They estimated their model using loan-level LoanPerformance data and the Case Shiller HPI, and their model allowed borrowers to default in order to increase their lifetime wealth or because of short-term budget constraints. While they found that the loan quality (e.g., the borrowers with poor credit and high payment to income ratios) impacted default rates in the subprime market, they concluded that "one main driver of default is the nationwide decrease in home prices." Borrowers with a mortgage liability that was higher than the value of their home could increase their wealth by deciding to default.

Bhutta, Dokko, and Shan, on the other hand, found that, while changes in housing prices mattered, borrowers faced high default and transaction costs and so did not "ruthlessly exercise the default option at relatively low levels of negative equity." For example, they reported that mortgage delinquency and subsequent foreclosure reduced the borrower's credit score by 21% and that borrowers in recourse states, where they faced higher legal costs, were less likely to strategically default. They concluded that borrowers were more likely to strategically default if they were deeply underwater, but not so at low levels of negative equity. "About half of defaults occurring when equity is below −50% are strategic but when negative equity is above −10%, we find that the combination of negative equity and liquidity shocks or life events drives default."[37]

[33] In general, unemployment was used as a proxy for negative income shocks.

[34] Laurie S. Goodman, Roger Ashworth, Brian Landy, and Ke Yin, "Negative Equity Trumps Unemployment in Predicting Defaults," *Journal of Fixed Income* 19 (2010), 67–72.

[35] Joseph Gyourko and Joseph Tracy, "Unemployment and Unobserved Credit Risk in the FHA Single Family Mortgage Insurance Fund," National Bureau of Economic Research Working Paper (2013).

[36] Patrick Bajari, Chenghuan S. Chu, and Minjung Park, "An Empirical Model of Subprime Mortgage Default," National Bureau of Economic Research Working Paper (2008).

[37] Neil Bhutta, Jane Dokko, and Hui Shan, "The Depth of Negative Equity and Mortgage Default Decisions," Federal Reserve Board Finance and Economics Discussion Series (2010), 3.

Unemployment Matters

Campbell and Cocco used a theoretical model of a rational utility-maximizing household, in which the borrower had to decide every month whether they would default, pay off their loan, or continue to make their mortgage payment and remain current on their loan, to show that both home equity and income constraints affected the risk of default.[38] They found that income constraints shifted the equity threshold at which a borrower would exercise the default option. Foote, Gerardi, Goette, and Willen found that unemployment shocks had a greater impact on mortgage defaults than a borrower's being in a negative equity position, given a specific level of equity reduction.[39] Elul, Souleles, Chomsisengphet, Glennon, and Hunt found that the marginal effect of changes in the local unemployment rate was statistically significant but much smaller in magnitude than home equity or illiquidity.[40] They also found that unemployment interacted strongly with the combined loan-to-value ratio (CLTV).

Finally, Gyourko and Tracy argued that the underperformance of unemployment in many default studies was due, in large part, to attenuation bias, as regional unemployment rates were "noisy" proxies for the employment status of the borrower.[41] They argued that the noisier the market-level unemployment rate was as a proxy, the less impact unemployment would appear to have on default risk. Using a 5% sample of loan-level data from January 2005 to March 2012, and county - and state-level unemployment rates reported by the Bureau of Labor Statistics, Gyourko and Tracy used a simple linear probability model to estimate the probability of 90-day delinquencies. Their model accounted for MSA-level unemployment rates, as well as LTV, vintage year of the loan pool, FICO, loan type, loan purpose, property type, and whether the loan was taken out in a non-recourse state. They found that the regression coefficient on the unemployment rate understated the true effect of the borrower's being unemployed by a factor of about 180.[42] They concluded that unemployment risk was likely a very important factor in explaining default and, if properly captured, could be more influential than measures of home equity or credit scores.

Liquidity Matters

Laufer estimated that 30% of the recent surge in mortgage defaults was due to income shocks and liquidity constraints and that another 30% was due to early homebuyers who

[38] John Y. Campbell and Joao F. Cocco, "A Model of Mortgage Default," *Journal of Finance* 70/4 (August 2015), 1495–1554.

[39] Christopher L. Foote, Kristopher Gerardi, and Paul S. Willen, "Negative Equity and Foreclosure: Theory and Evidence," Federal Reserve Bank of Boston Public Policy Discussion Papers No. 08-3 (June 2008).

[40] Ronel Elul, Nicholas S. Souleles, Souphala Chomsisengphet, Dennis Glennon, and Robert Hunt, "What 'Triggers' Mortgage Default?" *American Economic Review* 100/2 (May 2010), 490–4.

[41] Gyourko and Tracy, "Unemployment and Unobserved Credit Risk in the FHA Single Family Mortgage Insurance Fund."

[42] Gyourko and Tracy, "Unemployment and Unobserved Credit Risk in the FHA Single Family Mortgage Insurance Fund," 10.

borrowed against the equity in their homes when home prices were on the rise.[43] Elul, Souleles, Chomsisengphet, Glennon, and Hunt found that liquidity constraints were important determinants of default behavior.[44] Using loan-level LPS data and detailed credit bureau information from Equifax, with information on the second liens and credit card utilization, they assessed the relative importance of negative equity and illiquidity on mortgage default. They focused on mortgages originated in 2005 and 2006, as these borrowers would not have had time to build up equity in their homes and would have been the most likely to experience negative equity during their sample period. They found that both negative equity and illiquidity—measured by high credit card utilization—were significantly associated with mortgage default and that both were larger in magnitude than the marginal effect of changes in the local unemployment rate. In addition, they found that illiquidity interacted strongly with increases in CLTV.

Developments in the Econometric Modeling of Mortgage Defaults

The academic literature on mortgage defaults reflects the evolution of econometric modeling from the use of linear regressions to examine aggregate default rates through the use of logit and hazard models to analyze the individual borrower's decision to stop payments.[45] These methodological changes mirror the development of detailed loan-level databases that track the performance of each mortgage over time. Logit and hazard regressions remain the dominant models in the academic and industry research on mortgage defaults.

Linear Models

The early literature relied on data on defaults or interest rates aggregated to the financial institution level for loans originated over a specific time frame. For example, Jung used

[43] Steven Laufer, "Equity Extraction and Mortgage Default," Federal Reserve Board Working Paper (2013). Bennett, Peach, and Persistaiani also found that 66% of homeowners who refinanced three times took equity out of their property as compared to 43% of one-time refinancers. In addition, repeat refinancers started with a lower LTV than single refinancers, but cashing out, the LTV increases as second or third refinances take place. Paul Bennett, Richard Peach, and Stavros Peristiani, "Structural Change in the Mortgage Market and the Propensity to Refinance," *Journal of Money, Credit, and Banking* 33/4 (November 2001), 955–75.

[44] Elul, Souleles, Chomsisengphet, Glennon, and Hunt, "What 'Triggers' Mortgage Default?"

[45] An, Deng, Rosenblatt, and Yao and Quercia and Stegman provide a detailed review of econometric models employed in the mortgage default literature: Xudong An, Yongheng Deng, Eric Rosenblatt, and Vincent W. Yao, "Model Stability and the Subprime Mortgage Crisis," *Journal of Real Estate Finance and Economics* 45/3 (2012), 545–68; and Quercia and Stegman, "Residential Mortgage Default: A Review of the Literature."

aggregate data from 31 financial institutions to document a positive correlation between LTV and interest rates.[46] Because of the low number of observations the author could not conduct a test to assess the statistical significance of his results. Page developed a multivariate regression analysis of mortgage risk, focusing on property values and debt-to-income ratios, among other variables, to explain interest rate premiums.[47] The paper relied on logarithmic regressions to assess the relationship between default rates and several explanatory variables. It was not until Von Furstenberg that attention shifted toward default rates as a measure of mortgage risk.[48] The early research continued to study the determinants of default rates of FHA/VA loans using linear regression models.

The availability of loan-level data led to a focus on binary response models—models where the outcome is binary and the models estimate a probability function.[49] For example, Herzog and Earley defined the dependent variable as zero if the loan was current and as one if the loan was noncurrent, and they used a multiple linear regression as the functional form.[50] This specification had the obvious problem that the predicted probabilities for default generated by the model would not necessarily fall between zero and one.

Logit Models

Jackson and Kaserman introduced index models to the study of mortgage defaults, of which the logit and probit are special cases. Specifically, the logit or probit models limit the fitted values for the probability of default to lie inside the unit interval.[51]

Campbell and Dietrich and Vandell and Thibodeau implemented logit models using loan-level data.[52] Across academic papers, there were three steps commonly used to set up a logit model. First, a definition of default was adopted such that each monthly observation of a particular loan could be coded as zero if the loan was not in default or one if the loan was in default. Academic studies varied in their definition of default, specifying default as 60 days or more delinquent, 90 days or more delinquent, or loans that had been foreclosed on and/or liquidated. Second, default was treated as an absorbing state such that the loan, once it defaulted, was assumed to stay in default until termination.[53]

[46] Allen F. Jung, "Terms on Conventional Mortgage Loans on Existing Homes," *Journal of Finance* 17 (1962), 432–43.

[47] Alfred N. Page, "The Variation of Mortgage Interest Rates," *Journal of Business* 37/3 (1964), 280–94.

[48] Von Furstenberg, "Default Risk on FHA-Insured Home Mortgages as a Function of the Terms of Financing: A Quantitative Analysis."

[49] Jeffrey M. Wooldridge, *Econometric Analysis of Cross Section and Panel Data* (Cambridge, MA: MIT Press, 2010).

[50] Herzog and Earley, "Home Mortgage Delinquency and Foreclosure."

[51] Wooldridge, *Econometric Analysis of Cross Section and Panel Data*.

[52] Campbell and Dietrich, "The Determinants of Default on Insured Conventional Residential Mortgage Loans"; and Vandell and Thibodeau, "Estimation of Mortgage Defaults Using Disaggregate Loan History Data."

[53] This setup implies that each loan will typically be represented by several monthly observations.

Third, the set of explanatory variables to be included in the model were specified. The effect of time was often modeled using a polynomial function over months since origination to account for trends in defaults over the lifetime of loans.

Zorn and Lea used multinomial logit models to analyze the probabilities that loans would stay current, fall into delinquency or default, or be prepaid.[54] Multinomial logit models allow researchers to model more than two outcomes. These models can be employed to account for the possibility that borrowers might prepay their mortgages.

Hazard Models

Quigley and Van Order applied hazard models to the study of mortgage defaults.[55] Hazard models are a part of survival analysis, a form of statistical modeling used to study the occurrence and timing of events.[56] These econometric models focus on the hazard function, which estimates the probability of default in a particular month conditional on the loan surviving up to that month. The hazard function allows for different rates of default throughout the lifetime of loans, which allows researchers to analyze the behavior of borrowers while taking into account the performance history of each loan over time. Unlike the logit and probit models which consider categorical responses, hazard models of mortgage default study durations or time to default.[57]

The Cox proportional hazard model has been used often in the academic mortgage default literature.[58] In this model, the hazard for any individual is a fixed proportion of the hazard for any other individual. The explanatory variables, along with the estimated coefficients, determine whether an individual has a proportionate increase or decrease in risk as compared to others.[59] Cox's method does not require that one would choose a specific shape to represent the hazard function. The hazard function can be constant, decreasing, increasing, or taking any possible form.[60] This flexibility has made the Cox proportional hazard model very popular among researchers. However, the Cox proportional hazard model ignores competing risks such as prepayments.

[54] Peter M. Zorn and Michael J. Lea, "Mortgage Borrower Repayment Behavior: A Microeconomic Analysis with Canadian Adjustable Rate Mortgage Data," *Real Estate Economics* 17/1 (1989), 118–36.

[55] Quigley and Van Order, "Defaults on Mortgage Obligations and Capital Requirements for U.S. Savings Institutions: A Policy Perspective."

[56] There are many different kinds of survival models including Kaplan–Meier estimators, exponential regression, log-normal regression, proportional hazards, competing risk models, and discrete time models. See, for example, Narayanaswamy Balakrishnan and Calyampudi R. Rao, *Handbook of Statistics: Advances in Survival Analysis* (Amsterdam: Elsevier, 2004).

[57] Technically, a logit or probit could be set up in which each month of potential default is its own category.

[58] See, for example, Andrew Haughwout, Ebiere Okah, and Joseph S. Tracy, "Second Chances: Subprime Mortgage Modification and Re-default," Federal Reserve Bank of New York Staff Report No. 417 (December 2009).

[59] Germán Rodríguez, *Parametric Survival Models*, Princeton University Lecture Notes (2010).

[60] Mario Cleves, William Gould, Roberto G. Gutierrez, and Yulia V. Marchenko, *An Introduction to Survival Analysis Using Stata* (College Station: Stata Press, 2010).

Competing risks are events whose occurrence dramatically modifies the probability of occurrence of the event under investigation.[61] The Cox proportional hazard model is inadequate in the presence of competing risks because it fails to acknowledge that default will never occur if the loan is prepaid. Deng, Quigley, and Van Order implemented a competing-risks hazard model to study mortgage defaults.[62] For example, competing risks models consider that loans can be terminated through events other than default. These survival analysis models consider that once a loan is prepaid, the probability of default in the future is zero.

Mortgage Default Models Used in the Mortgage Industry

The statistical models that market participants use to estimate defaults are similar to, and based in part on, the academic literature. Investors, banks, regulators, and other institutions use models based on loan-level data to evaluate the default risk of a mortgage pool.[63] The mortgage industry has also adopted logit and hazard models in its analysis of default risk.[64] However, while the academic literature has mainly focused on studying the determinants of mortgage defaults—whether defined as 60 or 90 days' delinquency, foreclosure, or liquidation—the mortgage industry is ultimately concerned with the prediction of cash flows and losses associated with a particular mortgage pool.[65] As a result, market participants have always focused on the timing of migration of mortgages from one delinquency status to another. Meanwhile, academics have focused mainly on modeling the terminal state of loans, i.e., default in its different definitions.

There are several factors that analysts consider when predicting mortgage losses and cash flows. For example, the time required to process a foreclosure may affect costs incurred by the servicer and, therefore, mortgage losses.[66] Similarly, whether the state has a statutory right of redemption will likely increase the time between the borrower's default and the lender's foreclosure on the property, thereby affecting the cash flows received by the servicer, the lender, and the investors.

[61] Ted A. Gooley, Wendy Leisenring, John Crowley, and Barry E. Storer, "Estimation of Failure Probabilities in the Presence of Competing Risks: New Representations of Old Estimators," *Statistics in Medicine* 18 (1999), 695–706.

[62] Yongheng Deng, John M. Quigley, and Robert Van Order, "Mortgage Default and Low Downpayment Loans: The Costs of Public Subsidy," *Regional Science and Urban Economics* 26 (1996), 263–85.

[63] See, for example, CoreLogic (2014). CoreLogic, *RiskModel* (2014). Retrieved from <http://www.corelogic.com/downloadable-docs/riskmodel-data-sheet.pdf>.

[64] An, Deng, Rosenblatt, and Yao, "Model Stability and the Subprime Mortgage Crisis."

[65] CoreLogic (2014).

[66] Lakhbir S. Hayre and Manish Saraf, "A Loss Severity Model for Residential Mortgages," *Journal of Fixed Income* 18/2 (2008), 5–31.

Transition Models

Transition models track the migration of mortgages through different delinquency categories. In a transition model, each loan is assigned a probability of transition from its current delinquency category into other possible categories each month. These transitions typically represent a combination of borrower and servicer actions.[67] For example, the migration from a current status into 30 days delinquency is determined by the borrower's decision not to make a payment. Meanwhile, the sale of a foreclosed property is a result of borrower and servicer actions within the framework of prevailing foreclosure laws.

Table 28.2 represents an example of a loan-level transition matrix. Empty cells denote transition probabilities to be estimated from historical data. Non-empty cells reflect model assumptions. Some model assumptions, such as treating liquidation and prepayment as terminal statuses, are based on the definition of certain delinquency categories. For example, liquidations are usually defined as loans whose balance goes to zero and are not prepaid. This delinquency definition assumes that liquidation is a terminal status. This is reflected in the 100% cell from Liquidated to Liquidated that you see in the table. Other model assumptions, such as assuming no transitions from current to a 60 days delinquency, are simplifying rules intended to reduce the number of parameters to be estimated.

The transition probabilities can be estimated with various regression models. A regression is estimated for each delinquency category. Once the model is estimated, it is used to predict the probability that a loan will transition in the following month from current to current, current to 30 days delinquent, or current to prepaid. A similar analysis is used to estimate the remaining transitions.

The next step is to apply the estimated probabilities to forecast loan behavior until termination. Table 28.3 presents the number of possible trajectories for a loan that is current as of month t. There are three possible trajectories for the loan as of month $t+1$,

Table 28.2 Structure of a typical loan-level transition matrix

From/To	Current	30 DQ	60 DQ	90+ DQ	Foreclosure	REO	Liquidated	Prepaid
Current			0%	0%	0%	0%	0%	
30 Days DQ				0%	0%	0%	0%	
60 Days DQ					0%	0%	0%	
90+ Days DQ						0%		
Foreclosure								
REO	0%	0%	0%	0%	0%			0%
Liquidated	0%	0%	0%	0%	0%	0%	100%	0%
Prepaid	0%	0%	0%	0%	0%	0%	0%	100%

[67] Barclays Capital, *Barclays Loan Transition Model* (2010).

Table 28.3 Number of possible trajectories for a loan with a "current" status as of month *t*

Month	Number of Trajectories
$t+1$	3
$t+2$	8
$t+3$	22
$t+4$	65
$t+5$	202
$t+6$	644
$t+7$	2,076

eight possible trajectories as of month $t+2$, 22 possible trajectories as of month $t+3$, and so on.[68] After seven months the number of possible trajectories has already increased to 2,076.

Because of the large number of possible delinquency trajectories, transition models are usually implemented through simulations.

Mortgage Loan Modification Programs and Impact on Default Behavior

By the end of the fourth quarter of 2014, approximately 5.4 million US households, representing an estimated 10.8% of all homes with a mortgage, owed more on their homes than their homes were worth,[69] and 710,043 borrowers were seriously delinquent on their loans (60 days or more past due including bankruptcy).[70] Figure 28.7 presents the total number of foreclosures in process from the first quarter of 2008 to the fourth quarter of 2014. Foreclosures in process track mortgages for which servicers have begun, but

[68] For example, at $t+1$ the three possible trajectories are: {current, current}, {current, 30-days delinquent}, and {current, prepaid}.

[69] CoreLogic Equity Report, Fourth Quarter, 2014.

[70] The Office of Comptroller of the Currency (OCC) defines seriously delinquent loans as mortgages that are 60 or more days past due and all mortgages held by bankrupt borrowers whose payments are 30 or more days past due. The OCC Mortgage Metric Report, Fourth Quarter, 2014 provides following data on number of loans:

- 60–89 Days Delinquent—198,055
- 90 or More Days Delinquent—350,650
- Bankruptcy 30 or More Days Delinquent—161,338
- Total for Seriously Delinquent—710,043

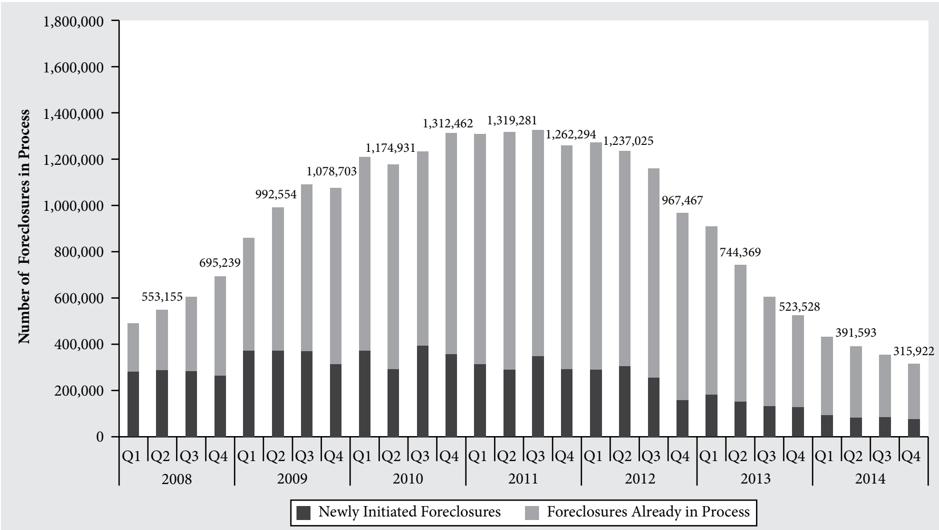

FIGURE 28.7 Foreclosures in process and newly initiated foreclosures

Note: The OCC defines newly initiated foreclosures as mortgages for which the servicers initiated formal foreclosure proceedings. Foreclosures in process are mortgages for which servicers have begun formal foreclosure proceedings but have not yet completed the process that would result in the loss of borrowers' homes.

Source: Office of the Comptroller of the Currency (OCC) Mortgage Metrics Reports, First Quarter 2009 through Fourth Quarter 2014

not completed, the formal foreclosure proceedings that would result in the loss of borrowers' homes. Figure 28.7 also includes newly initiated foreclosures. The total number of foreclosures in process was 489,119 in the first quarter of 2008 and reached a peak of 1,326,019 in the third quarter of 2011. Since then, the volume of foreclosures in process has declined. As of the end of 2014, there were 315,922 foreclosures in process. The number of newly initiated foreclosures also declined as there were 75,395 new foreclosures in the fourth quarter of 2014. From 2008 to 2012, there were, on average, 309,396 new quarterly foreclosures, but the pace has slowed to 114,089 during 2013 and 2014.

Loss Mitigation Methods

Given the surge in serious delinquencies and foreclosures resulting from the credit crisis, servicers and lenders have adopted various methods of loss mitigation, with and without government intervention, to deal with the foreclosure crisis. Historically, banks and lenders have worked with borrowers to help prevent foreclosure and to mitigate losses. In general, there are five methods to mitigate losses on mortgages. The first three methods of loss mitigation—repayment plans, forbearance, and loan modifications—apply to borrowers who are financially able and desire to continue their mortgage contracts. The last two methods—short sales and deed-in-lieu transfers—are voluntary home-loss workouts in which either the lender agrees to allow the borrower to sell the home on the market for a price below that owed in principal, interest, and other expenses, or the borrower agrees to turn over the title of the property to the lender to terminate the debt.[71] We briefly review the various methods below.

Repayment Plan

A repayment plan is a loss mitigation method in which the lender and the borrower agree to spread the delinquent amount over a specified period of time by adding a small amount each month to the principal and interest payment due. According to Cutts and Merrill, repayment plans are usually the first step in a workout process, given their ease of implementation and the lack of required changes to the formal terms of the mortgage contracts.[72] In addition, repayment plans explicitly provide for all principal and interest to be paid so that the investors incur no accounting losses. Based on an analysis of Freddie Mac loans in repayment plans during the period 2000 through 2006, Cutts and Merrill conclude that less delinquent loans at the start of the repayment plan are more likely to be cured. For example, 56% of loans that entered a prepayment plan when only 30 days delinquent cured their delinquency as compared to 29% of loans that were 90 days plus delinquent when entering a plan.[73]

Forbearance Agreements

A forbearance agreement provides temporary relief for a borrower in delinquency. In this case, the mortgage holder agrees to reduce or temporarily suspend payments for a given period of time called the "forbearance period." The lender also agrees not to foreclose on the property during the forbearance period. At the end of the forbearance period, the borrower will pay the delinquent amount as well as the amount that was reduced or suspended (including principal, interest, and fees) during the forbearance period. While forbearance agreements vary from lender to lender, the agreement can call for: (1) the amount owed to be paid as one lump sum at the end of the forbearance period; (2) the amount to be entered into a repayment plan so that a portion of it would be added to the regular principal and interest payment each month until the full amount was paid off, or (3) the lender to modify the loan contract to extend the term, essentially adding the amount owed to the end of the contract. As with repayment plans, the forbearance agreement explicitly provides for all principal and interest to be paid and for the investors to incur no accounting losses.

Loan Modification Programs

Loan modifications can be an effective tool in mitigating foreclosure for loans in the later stages of delinquency. In the case of a modification, the lender and borrower

[71] Amy Crews Cutts and William A. Merrill, "Interventions in Mortgage Default: Policies and Practices to Prevent Home Loss and Lower Costs," Freddie Mac Working Paper No. 08-01 (March 2008).

[72] Cutts and Merrill, "Interventions in Mortgage Default: Policies and Practices to Prevent Home Loss and Lower Costs."

[73] Cutts and Merrill, "Interventions in Mortgage Default: Policies and Practices to Prevent Home Loss and Lower Costs."

renegotiate the terms of the mortgage contract so as to minimize losses for the lender and to assist the distressed borrower in staying in their home. Modifications can include changes in the principal and/or interest terms of the mortgages.

Short Sales

A short sale, also known as a "pre-foreclosure sale," occurs when the mortgage servicer allows the borrower to sell the mortgaged property at a price less than the outstanding balance of the borrower's mortgage.[74,75] A short sale does not necessarily release the borrower's debt as they may still be liable for the deficiency, equal to the difference between the sale proceeds and the outstanding debt.[76]

Deed-in-Lieu Transfers

Mortgage servicers may also offer to accept a deed-in-lieu of foreclosure. In a deed-in-lieu of foreclosure, a borrower voluntarily transfers ownership of the property to the mortgage servicer in exchange for a release from all obligations under the mortgage.[77] In general, a deed-in-lieu expedites the foreclosure process for the mortgage lender.[78]

Liquidation or Foreclosure

Completed foreclosures are an indication of the ownership of properties being transferred to servicers or investors. Using data from the OCC's monthly Mortgage Metrics reports, Figure 28.8 presents home forfeiture actions—including completed foreclosures, short sales, and deed-in-lieu transfers—from the first quarter of 2008 though the fourth quarter of 2014. During the third quarter of 2010, home forfeiture reached its peak with 189,285 completed foreclosures, 56,270 short sales, and 1,729 deed-in-lieu of foreclosure actions. The number of home forfeiture actions continued to decline and were below first quarter 2008 levels by the fourth quarter of 2014.

There is a common misconception that borrowers lose their homes at the start of the foreclosure. However, on average, the foreclosure process takes a year to process, as measured from the last payment to the completed foreclosure. During this period many borrowers are able to reinstate their loans.[79]

[74] US Department of Housing and Urban Development, "Preforeclosure Sale: Frequently Asked Questions."

[75] Federal Housing Finance Agency, "FHFA Announces New Standard Short Sale Guidelines for Fannie Mae and Freddie Mac" [Press release], August 21, 2012.

[76] Federal Housing Finance Agency Office of Inspector General, "An Overview of the Home Foreclosure Process."

[77] Making Home Affordable, "Home Affordable Foreclosure Alternatives (HAFA) Program: Helping Homeowners Transition to More Affordable Housing" (July 2010).

[78] Federal Housing Finance Agency Office of Inspector General, "An Overview of the Home Foreclosure Process."

[79] Cutts and Merrill, "Interventions in Mortgage Default: Policies and Practices to Prevent Home Loss and Lower Costs."

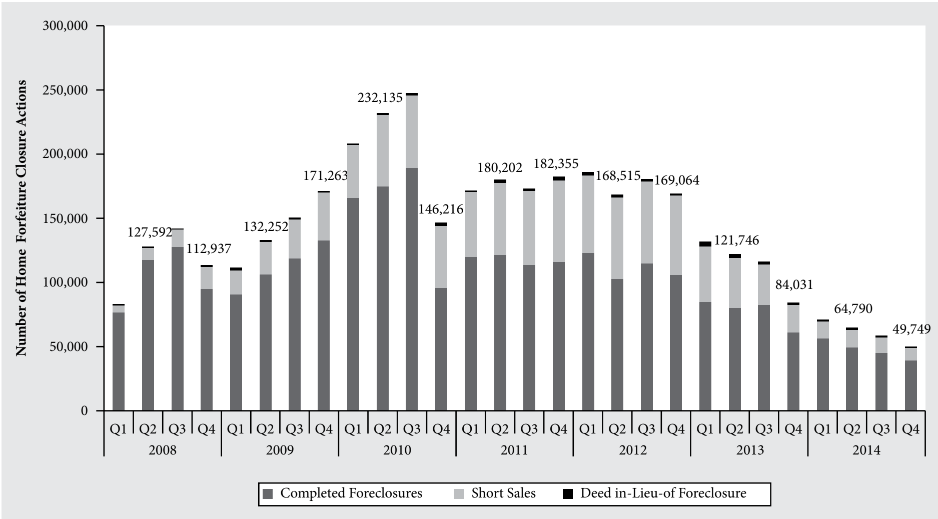

FIGURE 28.8 Completed foreclosures and other home forfeiture actions

Note: OCC reports state that home forfeiture actions include completed foreclosure sales, short sales, and deed-in-lieu of foreclosure. OCC reports define completed foreclosures as the ownership of properties being transferred to servicers or investors, short sales as sales of the mortgaged properties at prices that net less than the total amount due on the mortgages, and deed-in-lieu of foreclosure actions as actions in which borrowers transfer ownership of the properties to services in full satisfaction of the outstanding mortgage debt to lessen the adverse impact of the debt on borrowers' credit records.

Source: Data are obtained from the Office of the Comptroller of the Currency (OCC) Mortgage Metrics Reports, First Quarter 2009 through Fourth Quarter 2014

Foreclosure is the legal process by which a property can be sold and the proceeds of the sale are used to pay down the mortgage debt.[80] Once a loan is referred to foreclosure, the process is dictated by state law and, in some cases, local statutes in addition to the investors' guidelines for securitized loans.[81] The process and relevant time in foreclosure vary by state. There are two main types of foreclosure procedures: judicial foreclosures and nonjudicial foreclosures using the power of sale clause in deeds of trust.[82]

1. *Judicial Foreclosures*: Judicial foreclosures proceed through the court system.[83] All states allow judicial foreclosures, and some states require them. Under this procedure, the mortgage lender must file a lawsuit with the judicial system, and the

[80] Making Home Affordable, Glossary of Commonly Used Terms and Definitions. Available at <https://www.makinghomeaffordable.gov/get-answers/pages/get-answers-learning-glossary.aspx>.

[81] Making Home Affordable, Glossary.

[82] US Department of Housing and Urban Development, "Foreclosure Process." A small number of states allow for another type of foreclosure—strict foreclosure. In this type of foreclosure proceedings, the lender must file a lawsuit on the homeowner that has defaulted. If the borrower cannot pay the mortgage within a specific time frame specified by the court, the property is transferred to the mortgage holder.

[83] Federal Housing Finance Agency Office of Inspector General, "An Overview of the Home Foreclosure Process."

borrower receives a note in the mail demanding payment. In general, the borrower then has only 30 days to make the payment. If the borrower fails to do so after a certain time period, the mortgage is auctioned to the highest bidder. The auction is carried out by a local court or the sheriff's office.[84]

2. *Nonjudicial Foreclosures using the Power of Sale Clause*: Nonjudicial foreclosures proceed outside of the court system.[85] These foreclosures occur when deeds of trust that contain a power of sale clause are in effect rather than mortgages.[86] After a borrower has defaulted on his or her mortgage payments and an established waiting period ends, the mortgage company can directly conduct a public auction. Nonjudicial foreclosures are often more expedient, though they may be subject to judicial review to ensure the legality of the proceedings.[87]

However, foreclosure sales may not be the end of the story. In some states, a post-sale "redemption right" is available. This means that the borrower can still reclaim their home after it has already been sold at a foreclosure sale. To do so, the borrower must pay the outstanding mortgage balance and all costs incurred during the foreclosure process. The payment must be made within the redemption period which varies by state. The length of the redemption period can range from as short as ten days to as long as two years.[88]

Moreover, a "deficiency judgment" is also available in some states. In the event that a foreclosure sale does not provide proceeds that cover the full mortgage debt, the mortgage lender or its representative may sometimes seek a deficiency judgment—a legal judgment and obligation on the remaining amount of debt. A deficiency judgment is considered unsecured debt, similar to credit card debt. This implies that deficiency judgments are often difficult for lenders to collect, as many states place restrictions on wage garnishment and unsecured debts are generally dischargeable in bankruptcy. In addition, deficiency judgments are generally not available when nonjudicial foreclosures are used due to concerns of foreclosure sales price manipulations.[89] Table 28.4 documents the most common foreclosure methods and the average timeline by state.

Federal Modification Programs Following the Credit Crisis

In February 2009, the Obama Administration introduced the Making Home Affordable Program (MHA), a plan to stabilize the housing market and to help struggling homeowners

[84] US Department of Housing and Urban Development, "Foreclosure Process."

[85] Federal Housing Finance Agency Office of Inspector General, "An Overview of the Home Foreclosure Process."

[86] Legal Information Institute, "Non-Judicial Foreclosure," Cornell University Law School.

[87] US Department of Housing and Urban Development, "Foreclosure Process."

[88] Federal Housing Finance Agency Office of Inspector General, "An Overview of the Home Foreclosure Process."

[89] Federal Housing Finance Agency Office of Inspector General, "An Overview of the Home Foreclosure Process."

Table 28.4 Foreclosure laws by state

State	Most Common Foreclosure Process from Fannie Mae as of Nov. 2014	Time From Last Paid Installment to Foreclosure Sale (in Days)
(1)	(2)	(3)
1. Alabama	Nonjudicial	360
2. Alaska	Nonjudicial	450
3. Arizona	Nonjudicial	330
4. Arkansas	Nonjudicial	450
5. California	Nonjudicial	510
6. Colorado	Nonjudicial	420
7. Connecticut	Judicial	750
8. Delaware	Judicial	780
9. District of Columbia	Nonjudicial	300
10. Florida	Judicial	810
11. Georgia	Nonjudicial	330
12. Hawaii	Judicial	840
13. Idaho	Nonjudicial	540
14. Illinois	Judicial	630
15. Indiana	Judicial	570
16. Iowa	Judicial	630
17. Kansas	Judicial	420
18. Kentucky	Judicial	540
19. Louisiana	Judicial	510
20. Maine	Judicial	690
21. Maryland	Nonjudicial	660
22. Massachusetts	Nonjudicial	440
23. Michigan	Nonjudicial	300
24. Minnesota	Nonjudicial	390
25. Mississippi	Nonjudicial	360
26. Missouri	Nonjudicial	330
27. Montana	Nonjudicial	450
28. Nebraska	Nonjudicial	420
29. Nevada	Nonjudicial	690
30. New Hampshire	Nonjudicial	420
31. New Jersey	Judicial	750
32. New Mexico	Judicial	720
33. New York	Judicial	820
34. North Carolina	Nonjudicial	450
35. North Dakota	Judicial	630
36. Ohio	Judicial	570
37. Oklahoma	Judicial	570
38. Oregon	Nonjudicial	600
39. Pennsylvania	Judicial	750
40. Rhode Island	Nonjudicial	660
41. South Carolina	Judicial	600
42. South Dakota	Judicial	570

43. Tennessee	Nonjudicial	300
44. Texas	Nonjudicial	390
45. Utah	Nonjudicial	540
46. Vermont	Judicial	810
47. Virginia	Nonjudicial	390
48. Washington	Nonjudicial	660
49. West Virginia	Nonjudicial	300
50. Wisconsin	Judicial	510
51. Wyoming	Nonjudicial	330

Source: Fannie Mae, Foreclosure Time Frames and Compensatory Fee Allowable Delays Exhibit, <https://www.fanniemae.com/content/guide_exhibit/foreclosure-timeframes-compensatory-fees-allowable-delays.pdf>; Fannie Mae, Servicing Guide, E-3.2-15: Allowable Time Frames for Completing Foreclosure (11/12/2014), <https://www.fanniemae.com/content/guide/servicing/e/3.2/15.html>

get relief and avoid foreclosure.[90] The Administration also announced the creation of the Homeowner Affordability and Stability Plan (HASP) to help millions of struggling homeowners avoid foreclosure by refinancing or modifying their first mortgages. This plan has two primary components: (1) the Home Affordable Refinance Program (HARP), to help borrowers refinance distressed mortgage loans into new loans with lower rates; and (2) the Home Affordable Modification Program (HAMP), to help homeowners at "imminent risk of default" on their mortgages by modifying their loans.[91]

The cornerstone of the MHA program is HAMP, which provides eligible homeowners the opportunity to reduce their monthly mortgage payments to more affordable levels. Since its launch, the US Treasury added more modification programs under MHA to help those who are unemployed or struggling with second liens and those seeking a short sale or deed-in-lieu of foreclosure. In 2014, the Obama Administration extended the application deadline for MHA programs to December 2016.[92]

The HAMP Program

In March 2009, the US Department of Treasury announced guidelines for MHA, including the HAMP program, the national mortgage modification program that provides eligible borrowers the opportunity to modify their first-lien mortgage so that their

[90] The White House, "Homeowner Affordability and Stability Plan: Fact Sheet" (February 2009).

[91] Consumer Compliance Outlook, "Consumer Compliance Outlook: Third Quarter 2009—An Overview of the Home Affordable Modification Programs," <https://consumercomplianceoutlook.org/2009/third-quarter/q3_02/>.

[92] US Department of Treasury, "Secretary Lew Unveils New Efforts to Assist Struggling and Prospective Homeowners, Provide More Affordable Options for Renters" [Press release], June 26, 2014. Available at <http://www.treasury.gov/press-center/press-releases/Pages/jl2444.aspx>.

monthly payments can become more affordable.[93,94] Under HAMP, mortgage servicers could, for eligible borrowers and depending upon the requirements applicable to each investor, reduce interest rates, extend the term of the loan, and/or apply principal forbearance and/or principal forgiveness to achieve a monthly payment equal to 31% of the borrowers' monthly gross income.[95]

The March 4, 2009 HAMP guidelines set out the program features, including eligibility requirements; required underwriting analysis; the standard waterfall or process to be used to modify eligible loans; modification terms, fees, and charges; and more.[96] On April 6, 2009, the Treasury provided further program guidance for mortgage loans not owned by Fannie Mae or Freddie Mac.[97] According to Supplemental Directive 09-01, borrowers who met the initial criteria entered into a trial period of three months "or longer if necessary to comply with applicable contractual obligations"[98] during which they had to make trial payments based on current income and provide financial information and other documentation to demonstrate their eligibility for a HAMP permanent modification.[99]

Eligibility for a HAMP trial/modification depends on various factors, including the date of mortgage origination, first-lien status, financial hardship, and owner occupancy. Table 28.5 and Table 28.6 present HAMP eligibility criteria for Fannie Mae and non-GSE mortgages, respectively. According to the Treasury Supplemental Directive 09-01, the modified payment during the trial period was set to 31% of the borrower's monthly gross income.[100] In addition, the servicer would determine the mortgage payment modification based on a "waterfall" analysis that, in general, capitalized certain overdue amounts of the current mortgage, reduced the interest rate, extended the term of the loan, and provided principal forbearance and/or forgiveness.[101]

Eligibility requirements for HAMP have changed over time. Table 28.6 reflects the eligibility requirements as of June 2015.

Early in the HAMP program, between April 2009 and June 1, 2010 (the "stated income period"), servicers could initiate HAMP trials based on financial information obtained

[93] US Department of Treasury, "Home Affordable Modification Program Guidelines" (March 4, 2009).

[94] Fannie Mae was designated as the program administrator for HAMP. Congressional Oversight Panel, "December Oversight Report: A Review of Treasury's Foreclosure Prevention Programs" (December 14, 2010).

[95] US Department of Treasury, "Home Affordable Modification Program Guidelines."

[96] US Department of Treasury, "Home Affordable Modification Program Guidelines."

[97] US Department of Treasury, "Supplemental Directive 09-01: Introduction of the Home Affordable Modification Program" (April 6, 2009).

[98] US Department of Treasury, "Supplemental Directive 09-01: Introduction of the Home Affordable Modification Program," 17.

[99] US Department of Treasury, "Supplemental Directive 09-01: Introduction of the Home Affordable Modification Program."

[100] US Department of Treasury, "Supplemental Directive 09-01: Introduction of the Home Affordable Modification Program."

[101] US Department of Treasury, "Supplemental Directive 09-01: Introduction of the Home Affordable Modification Program."

Table 28.5 HAMP eligibility requirements for Fannie Mae mortgages

A mortgage loan is eligible for the HAMP if it is a Fannie Mae portfolio mortgage loan or MBS pool mortgage loan guaranteed by Fannie Mae and the …

Mortgage loan

1. **is a first lien conventional mortgage loan or a jumbo-conforming mortgage loan originated on or before January 1, 2009,**
2. has not been previously modified under HAMP,
3. is in foreclosure, delinquent, or default is reasonably foreseeable,
4. is secured by a one- to four-unit property, one unit of which is the borrower's principal residence, *(Cooperative share mortgages and mortgage loans secured by condominium units are eligible for the HAMP. Loans secured by manufactured housing units are eligible for the HAMP.)*

Property

5. the property securing the mortgage loan is not vacant or condemned,

Borrower

6. documents a financial hardship and represents that (s)he does not have sufficient liquid assets to make the monthly mortgage payments by completing a Home Affordable Modification Program Hardship Affidavit and provides the required income documentation, *(The documentation supporting income may not be more than 90 days old as of the date the servicer is determining HAMP eligibility.)*
7. has a monthly mortgage payment ratio of greater than 31 percent,
8. agrees to set up an escrow account for taxes and hazard and flood insurance prior to the beginning of the trial period if one does not currently exist,

Servicer

9. has in its possession a fully executed Home Affordable Modification Trial Period Plan on December 31, 2012.

Further,

- A borrower in active litigation regarding the mortgage loan is eligible for the HAMP.
- The servicer may not require a borrower to waive legal rights as a condition of the HAMP.
- A borrower actively involved in a bankruptcy proceeding is eligible for the HAMP at the servicer's discretion. Borrowers who have received a Chapter 7 bankruptcy discharge in a case involving the first lien mortgage who did not reaffirm the mortgage debt under applicable law are eligible, provided the Home Affordable Modification Trial Period Plan and Home Affordable Modification Agreement are revised as outlined in the *Acceptable Revisions to HAMP Documents* section of this Supplemental Directive.
- **Mortgage loans subject to full lender recourse, including MBS pool mortgage loans and portfolio mortgage loans are ineligible for the Fannie Mae HAMP. However, servicers should consider these mortgage loans for the non-GSE HAMP.**

Source: HAMP eligibility requirements for Fannie Mae portfolio mortgage loans and MBS pool mortgage loans guaranteed by Fannie Mae are from the Fannie Mae Announcement 09-05R, which was issued on April 21, 2009, and reposted on May 15, 2009.

verbally from the borrower.[102] For stated income trials, a mortgage would be permanently modified only after the borrower had made the required trial payments, provided documentation verifying the borrower's income, and fulfilled other required program

[102] US Department of Treasury, "Supplemental Directive 09-01: Introduction of the Home Affordable Modification Program."

Table 28.6 HAMP eligibility requirements for non-GSE mortgages

A non-GSE Mortgage Loan is eligible for the HAMP if the servicer verifies that all of the following criteria are met:

Mortgage loan

1. **is a first lien mortgage loan originated on or before January 1, 2009,**
2. has not been previously modified under HAMP,
3. is in foreclosure, delinquent or default is reasonably foreseeable,
4. is secured by a one- to four-unit property, one unit of which is the borrower's principal residence, *(Mortgages secured by cooperative shares, condominium units, and manufactured housing units are eligible for the HAMP. A loan originally secured by a non-owner-occupied property, for which the servicer can verify that the property is currently owner-occupied is eligible for HAMP. A borrower that was occupying the property but has been displaced, e.g. through military deployment or a job transfer, is eligible for HAMP.)*
5. **has a current unpaid principal balance prior to capitalization no greater than:**
   - **1 unit: $729,750**
   - **2 unit: $934,200**
   - **3 unit: $1,129,250**
   - **4 unit: $1,403,400**

Property

6. the property securing the mortgage loan is not condemned or uninhabitable,

Borrower

7. documents a financial hardship and represents that (s)he does not have sufficient liquid assets to make the monthly mortgage payments,
8. has a monthly mortgage payment (including principal, interest, taxes, insurance, association fees and existing escrow shortages) prior to the modification that is greater than 31 percent of the borrower's verified monthly gross income,
9. agrees to set up an escrow account for taxes and hazard and flood insurance prior to the beginning of the trial period if one does not currently exist,
10. has submitted an Initial Package on or before December 31, 2016 and the Modification Effective Date is on or before September 30, 2017.

Further,

- A borrower in active litigation regarding the mortgage loan is eligible for the HAMP.
- The servicer may not require a borrower to waive legal rights as a condition of the HAMP.
- Balloon loans that have matured or that mature during the HAMP trial period are eligible for HAMP subject to investor guidelines.
- The servicer may not require a borrower to make any "good faith" payment or up-front cash contribution to be considered for HAMP.
- The borrower must be a natural person (e.g., cannot be a corporation, partnership, limited liability company or other business entity). However, a loan secured by a property owned by an inter vivos revocable trust is eligible for HAMP as long as the borrower is a trustee and primary beneficiary of the trust.
- A borrower actively involved in a bankruptcy proceeding is eligible for HAMP at the servicer's discretion. Borrowers who have received a Chapter 7 bankruptcy discharge in a case involving the first lien mortgage who did not reaffirm the mortgage debt under applicable law are eligible for HAMP.
- Whether a borrower can qualify for HAMP if the mortgage loan is currently in the redemption period after a foreclosure sale is dependent on the amount of time remaining in the redemption period and other legal requirements of the state in which the property is located.

Note: Eligibility requirements are for HAMP Tier 1. Different requirements may apply for Tier 2 modifications.

Source: Making Home Affordable Program, "Handbook for Servicers of Non-GSE Mortgages," Version 4.5, as of June 1, 2015, <https://www.hmpadmin.com/portal/programs/docs/hamp_servicer/mhahandbook_45.pdf>

criteria.[103] The documentation process of stated income trials was associated with delays in determining eligibility for permanent modifications.[104] In response, the Treasury streamlined the documentation process[105] and required, for all trials starting on or after June 1, 2010 (the "verified income period"), that the borrower's income be verified before a HAMP trial was offered.[106] The Treasury made numerous other changes to the program requirements in its first year of operations to improve the efficiency of the program.[107]

Figure 28.9 presents the trends in the cumulative number of HAMP trials started, as well as the percentage of HAMP permanent modifications from the third quarter of 2009 through the fourth quarter of 2014. The percentage of HAMP permanent modifications is a measure of how many trials lead to permanent modifications and is calculated by dividing the cumulative number of HAMP permanent modifications by the cumulative number of HAMP trials started. The number of HAMP trials has since steadily increased and approximately 64% have become permanent modifications as of the fourth quarter of 2014.

Additional MHA Programs

Among wide-scale government initiatives the HARP, initiated in March 2009, is a plan to refinance performing borrowers of Fannie Mae and Freddie Mac owned or guaranteed mortgages with a high LTV into mortgages with lower interest rates.[108]

The Treasury launched additional programs under MHA to help struggling homeowners find a solution that was right for their situation. These included the principal reduction alternative, the Home Affordable Unemployment program, the Second Lien modification program (2MP), and the Home Affordable Foreclosure Alternative program (HAFA).[109]

[103] US Department of Treasury, "Supplemental Directive 09-01: Introduction of the Home Affordable Modification Program."

[104] See, for example, Congressional Oversight Panel, "October Oversight Report: An Assessment of Foreclosure Mitigation Efforts after Six Months" (October 9, 2009). Also see United States Government Accountability Office, "Troubled Asset Relief Program: Home Affordable Modification Program Continues to Face Implementation Challenges," GAO-10-556T (March 25, 2010). Also see Special Inspector General for the Troubled Asset Relief Program, "Factors Affecting Implementation of the Home Affordable Modification Program," SIGTARP-10-005 (March 25, 2010).

[105] US Department of Treasury, "Supplemental Directive 09-07: Home Affordable Modification Program—Streamlined Borrower Evaluation Process" (October 8, 2009).

[106] US Department of Treasury, "Supplemental Directive 10-01: Home Affordable Modification Program—Program Update and Resolution of Active Trial Modifications" (January 28, 2010). This directive required that all trials with effective dates on or after June 1, 2010 be evaluated using an initial documentation package. CitiMortgage implemented the change to verified income trials in March 2010, prior to the Treasury deadline. See US Department of Treasury, "Making Home Affordable Program: Servicer Performance Report through June 2010" (July 19, 2010).

[107] Special Inspector General for the Troubled Asset Relief Program, "Factors Affecting Implementation of the Home Affordable Modification Program."

[108] For more information, see <https://www.makinghomeaffordable.gov/steps/pages/step-2-program-harp.asp>.

[109] <http://www.treasury.gov/initiatives/financial-stability/TARP-Programs/housing/mha/Pages/Programs-Under-Making-Home-Affordable.aspx>.

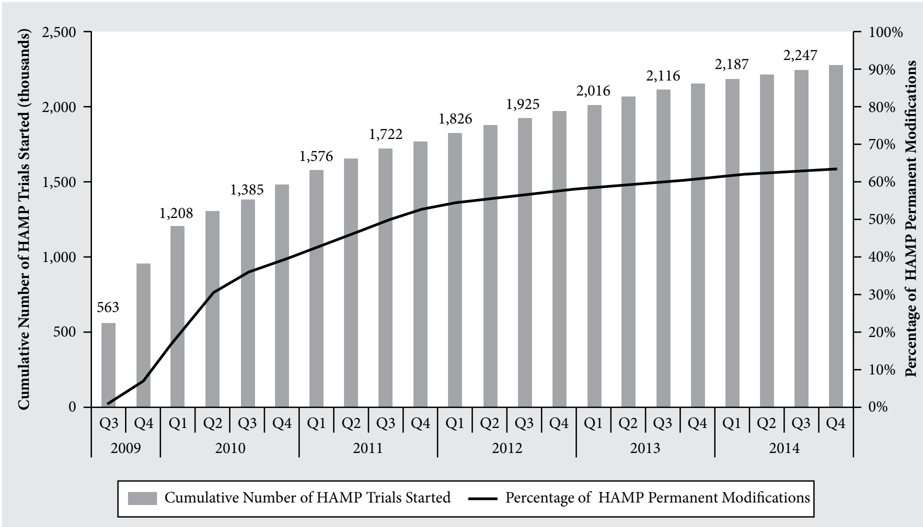

FIGURE 28.9 Cumulative number of HAMP trials started and the percentage of HAMP permanent modifications

Note: The percentage of HAMP permanent modifications is computed by dividing the cumulative number of HAMP permanent modifications by the cumulative number of HAMP trials started. The MHA Program Performance Reports were released on a monthly basis from July 2009 to May 2014. Starting in June 2014, the MHA Program Performance Reports are released on a quarterly basis.

Source: US Department of the Treasury, Making Home Affordable (MHA) Program Performance Reports

Previous Government Programs to Alleviate Foreclosure

Previous government efforts included:

- HOPE NOW

HOPE NOW was an alliance among counselors, mortgage companies, loan servicers, investors, regulators, and other mortgage market participants. The alliance was encouraged by the Department of the Treasury and the US Department of Housing and Urban Development. HOPE NOW's goal was to reach out to borrowers who were or may have become at-risk homeowners and to offer them workable options to avoid foreclosure. Options included modifications, refinancing, forbearance, and repayment plans. The partnership was introduced in October 2007 in an announcement by then Treasury Secretary Henry Paulson.[110]

- FHA HOPE for Homeowners program

[110] Testimony of Faith Schwartz, Executive Director of HOPE NOW, before the US House of Representatives Committee on the Judiciary Subcommittee on Commercial and Administrative Law (January 29, 2008).

The FHA HOPE for Homeowners program was designed to prevent qualified homeowners with pre-2008 mortgage loans from defaulting and avert foreclosure through refinancing into affordable, fixed-rate mortgages. Borrowers were able to refinance from a variable-rate mortgage to a fixed-rate mortgage but had to agree to an equity sharing plan with the FHA. If the borrower sold or refinanced the home, the FHA would receive all or a portion of the homeowner's equity based on the length of time since the HOPE refinancing was executed. The Hope for Homeowners Act was authorized under the Housing and Economic Recovery Act of 2008 and ran until September 20, 2011.[111]

- FDIC pilot modification of loans held by IndyMac and "Mod in a Box" guidelines

The FDIC, as conservator of IndyMac, implemented a modification program in August 2008 aimed primarily at addressing troubled IndyMac Alt-A mortgages. The FDIC designed a systematic and streamlined approach to loan modifications to place borrowers into affordable, long-term mortgages while achieving an improved return for bankers and investors compared to the results of foreclosure. Two requirements of the program were that the modification had to result in a positive net present value as compared to a foreclosure option and the monthly payment could not represent more than 31% of the borrower's gross monthly income, known as the front-end debt-to-income ratio. In November 2008, the FDIC released its "Mod in a Box" guidelines to aid servicers and financial institutions in developing a systematic and streamlined approach to modifying loans based on the FDIC Loan Modification Program initiated at IndyMac.[112]

As illustrated in Figure 28.10, the Office of the Comptroller of the Currency (OCC) reports the total number of new home retention actions between 2008 through 2014 by type of action: payment plans, HAMP trials and modifications, and other trials and modifications. There have been about 100,000 new payment plans every quarter since 2008. HAMP trial-period plans started in 2009 with 650,000 trials, and 800,000 more trials started in the period 2010 to 2014. The number of new home retention actions peaked in the third quarter of 2009 at almost 700,000 proceedings, but has declined as the number of borrowers in serious delinquency and foreclosure has also dwindled.

Assessment of the Effectiveness of Modifications during the Most Recent Credit Crisis

Policymakers and academics have examined the rate of modifications following the collapse in housing prices during the credit crisis, and there remains a controversy over

[111] HOPE for Homeowners: FHA Refinance Loan Options for Homeowners. Available at <http://www.fha.com/hope_for_homeowners>.

[112] FDIC (2008). "FDIC Implements Loan Modification Program for Distressed IndyMac Mortgage Loans" [Press release]. See <http://www.fdic.gov/news/news/press/2008/pr08067.html>, <http://www.fdicoig.gov/reports10/10-001EV.pdf>, and <https://www.fdic.gov/news/news/press/2008/pr08121.html>.

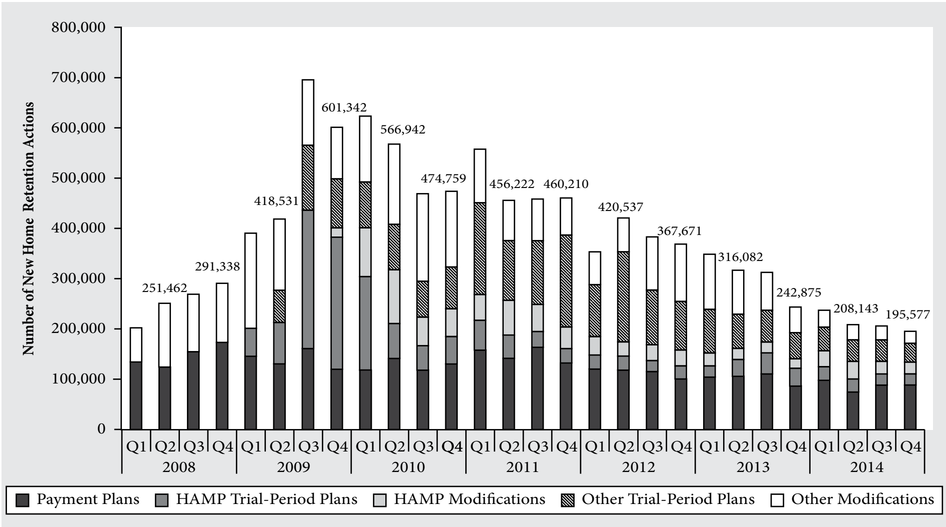

FIGURE 28.10 New home retention actions

Note: OCC Mortgage Metrics Reports state that home retention actions include loan modifications, in which servicers modify one or more mortgage contract terms; trial-period plans, in which the loans will be converted to modifications upon successful completion of the trial periods; and payment plans, in which no terms are contractually modified but borrowers are given time to catch up on missed payments.

Source: Office of the Comptroller of the Currency (OCC) Mortgage Metrics Reports, First Quarter 2009 through Fourth Quarter 2014

the implications of the unprecedented increase in foreclosures and the effectiveness of modifications. This controversy is not new. Agarwal, Amromin, Ben-David, Chomsisengphet, Piskorski, and Seru summarized academic debates on previous government modification programs: "There has been a long-standing debate among economists on the effects of such interventions. On the one hand, proponents argue that such policies prevent excessive foreclosures that may not only lead to deadweight losses for borrowers and lenders, especially if debt contracts are incomplete (Bolton and Rosenthal 2002), but could also generate negative externalities for the society (Campbell et al. 2010; Mian, Sufi, and Trebbi 2011; and Guiso, Sapienza, and Zingales 2011). Moreover, these policies also help reduce high levels of debt that may distort household consumption and investment decisions (Mian and Sufi 2012). On the other hand, critics argue that such policies potentially create moral hazard problems that are likely to raise the cost of credit in the long run and may also have undesirable redistributional consequences (Becker 2009; Posner 2009)."[113]

Academics have examined the effectiveness of the various modification programs following the recent credit crisis, and we summarize the key findings in this section. Many of the recent studies depend on performance data that the OCC and the OTS receive from the largest banks and thrifts that service mortgage portfolios ("OCC/OTS database"). The OCC/

[113] Sumit Agarwal, Gene Amromin, Itzhak Ben-David, Souphala Chomsisengphet, Tomasz Piskorski, and Amit Seru, "Policy Intervention in Debt Renegotiation: Evidence from the Home Affordable Modification Program," NBER Working Paper (June 2013).

OTS database tracks 60% of all first mortgages outstanding in the US, both on balance sheets and for third parties, totaling 35 million loans valued at over $6 trillion dollars.[114]

Trends in Modifications and Re-defaults

We rely on the monthly Mortgage Metrics reports issued by the OCC and OTS to summarize the number of mortgage modifications as well as the re-default rates by quarter from 2008 through the end of 2014.

Figure 28.11 presents the number of HAMP modifications and other modifications instituted by quarter and the rate of re-default for these modified loans from the fourth quarter of 2009 to the fourth quarter of 2013. A modified loan is in re-default if it becomes 60 or more days delinquent, and we show the re-default rate at 12 months after modification. In the first quarter of 2010, there were 100,226 HAMP modifications and 129,512 other modifications. Of these modifications, 19.40% of HAMP modifications re-defaulted in the first 12 months after modification whereas 34.20% of the other modifications re-defaulted in the first 12 months after modification. HAMP re-default rates are lower than the re-default rates of other modifications in this time period, but HAMP modifications (791,251) are outnumbered by other modifications (1,742,977). Both re-default rates have declined, but there is a slight uptick in re-default rates for the more recent modifications in the second half of 2013.

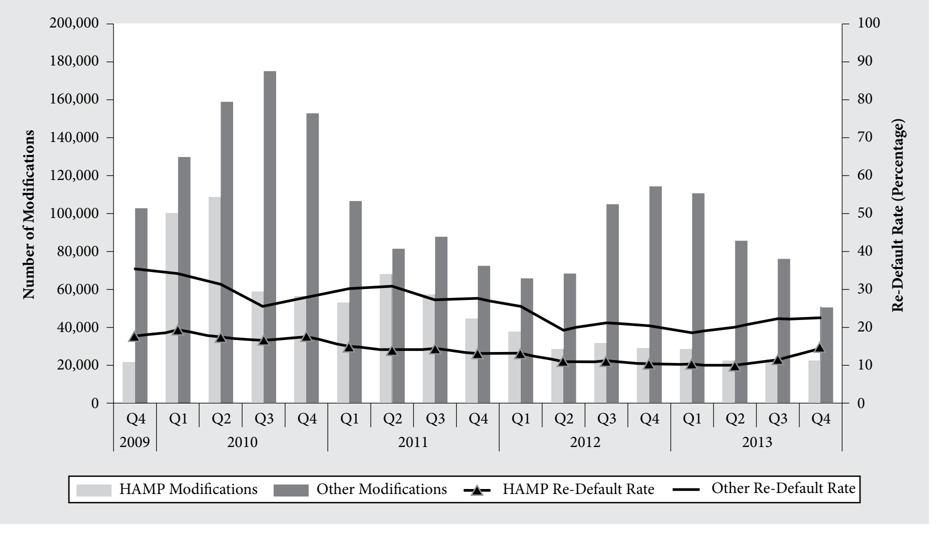

FIGURE 28.11 Re-default rate of HAMP and other modifications

Note: A mortgage is considered to have re-defaulted if it becomes 60 or more days delinquent after modification.

Source: Office of the Comptroller of the Currency (OCC) Mortgage Metrics Reports, First Quarter 2011 through Second Quarter 2011, Second Quarter 2012 through Fourth Quarter 2014

[114] John C. Dugan, Remarks before the OTS 3rd Annual National Housing Forum, Washington, DC (December 8, 2008).

Impact of Modifications on Foreclosure Rates

Agarwal, Amromin, and Ben David examined the effectiveness of the government intervention using HAMP to reduce the foreclosure rates. The authors found that HAMP had a modest impact on reducing foreclosures and reached only one third of its three to four million targeted borrowers in trouble.[115] The authors concluded that the servicers responded to the HAMP program by conducting more modifications among eligible loans, although the increase fell significantly short of the goal of the HAMP program. Moreover, there was an adverse impact on the effectiveness of the private modifications that the servicers negotiated with borrowers outside of HAMP.[116]

Haughwout, Okah, and Tracy examined how modified mortgages performed using loan-level data for loans originated between 2004 and 2007.[117] The authors estimated that about 57% of the modified loans re-defaulted within a year and that the form and magnitude of the modifications made a significant difference in the performance of modified loans.[118] The authors found that principal forgiveness was a more effective modification method as compared to reductions in interest payments. Quercia and Ding came to a similar conclusion about the effectiveness of principal reduction as a modification tactic as it helped restore the borrowers' equity position in their homes.[119]

Foote, Gerardi, and Willen argued that forbearance was a much more effective tool for reducing foreclosure than modifications because it addressed the problem of incomplete information that the lenders faced when trying to identify the borrowers who were truly at risk of default. The authors explained that modifications were attractive to all borrowers, regardless of whether they were in financial distress, whereas forbearance was attractive only to borrowers who were really in trouble. As a consequence, the cost of forbearance was low, which meant that lenders could offer larger benefits.[120] The authors concluded that the most effective way to avoid moral hazard problems and to reduce foreclosures was to offer forbearance programs that allowed borrowers to delay, but not to avoid, eventually repaying the mortgage.

Adelino, Gerradi, and Willen argued that securitization did not limit rates of modifications based on their empirical study, and instead explained that there were subtler reasons for the low rates of modifications. Using the OCC/OTS database of about 60% of all mortgages originated between 2005 and 2007, they examined the determinants of mortgage modifications and found that only 3% of seriously delinquent loans received a

[115] Agarwal, Amromin, Ben-David, Chomsisengphet, Piskorski, and Seru, "Policy Intervention in Debt Renegotiation: Evidence from the Home Affordable Modification Program."

[116] Agarwal, Amromin, Ben-David, Chomsisengphet, Piskorski, and Seru, "Policy Intervention in Debt Renegotiation: Evidence from the Home Affordable Modification Program."

[117] Haughwout, Okah, and Tracy, "Second Chances: Subprime Mortgage Modification and Re-default."

[118] Haughwout, Okah, and Tracy, "Second Chances: Subprime Mortgage Modification and Re-default."

[119] Roberto G. Quercia and Lei Ding, "Loan Modifications and Redefault Risk: An Examination of Short-Term Impacts," *Cityscape: A Journal of Policy Development and Research* 11/3 (2009), 171–93.

[120] Foote, Gerardi, and Willen, "Negative Equity and Foreclosure: Theory and Evidence."

concessionary modification within the first year of their serious delinquency, only 8% received any form of modification, and there were mostly no statistically significant differences between the rate of renegotiations for private-label and portfolio loans.[121] They also found that the unconditional probability that a modified mortgage re-defaulted in the six-month period following the modification was very large, about 20%–40% for payment-reducing modifications and 40%–50% for all modifications. In addition, there were no statistically significant differences between the re-default rates of private-label and portfolio loans.[122]

Using the OTS/OCC database on loss mitigation methods and performance of about 64% of all US mortgage loans, Agarwal, Amromin, Ben-David, Chomsisengphet, and Evanoff examined the factors affecting the decisions of lenders and services to mitigate losses for troubled mortgages, prior to the government intervention using federal programs such as HAMP in 2009. They found evidence that the ability to pay the mortgage payments—as opposed to strategic defaults due to negative equity—caused re-defaults after modifications. Their regression models suggested that the probability of default declined by about four percentage points for every one percentage point decline in mortgage interest rates.[123]

Key Points

- Trends in housing prices, interest rates, unemployment, and consumer leverage together with delinquency and foreclosure rates show improvements since the peak of the credit crisis but they are not back to pre-crisis rates.
- The debate over the causes of the mortgage defaults among academics and industry participants continues.
- Factors that academics examine when modeling defaults include changes in housing prices, unemployment rates, loan and borrower characteristics, underwriting guidelines, moral hazard, securitization, and illiquidity, among others.
- There have been significant developments in the econometric tools used to analyze defaults. Models have evolved from simple linear regressions to discrete choice models and survival analysis including Cox proportional hazard and competing risk models.
- Foreclosure rates peaked at 1.3 million borrowers in 2011 and have steadily declined since then, reaching pre-2008 levels.

[121] According to Mayer et al. (2012), this result held even after controlling for the various characteristics of the borrowers and loans and was robust to various subsamples and definitions of modifications. Christopher Mayer, Edward Morrison, Tomasz Piskorski, and Arpit Gupta, "Mortgage Modification and Strategic Behavior: Evidence from a Legal Settlement with Countrywide," Columbia Law and Economics Working Paper (October 11, 2012).

[122] Manuel Adelino, Kristopher Gerardi, and Paul S. Willen, "Why Don't Lenders Renegotiate More Home Mortgages? Redefaults, Self-Cures and Securitization," NBER Working Paper No. 15159 (July 2009).

[123] Sumit Agarwal, Gene Amromin, Itzhak Ben-David, Souphala Chomsisengphet, and Douglas D. Evanoff, "Market-Based Loss Mitigation Practices for Troubled Mortgages Following the Financial Crisis," Fisher College of Business Working Paper No. 2010-03-019 (October 2010).

- There are five methods to mitigate losses on mortgages. The first three methods of loss mitigation—repayment plans, forbearance, and loan modifications—apply to borrowers who are financially able and desire to continue in their mortgage contracts. The last two methods—short sales and deed-in-lieu transfers—are voluntary home-loss workouts in which either the lender agrees to allow the borrower to sell the home on the market for a price below that owed in principal or to eliminate the mortgage obligation by transferring the ownership of the property to the bank.
- Foreclosure is the legal process by which a property can be sold and the proceeds of the sale are used to pay down the mortgage debt. Foreclosure is dictated by state law and, in some cases, local statutes, in addition to the investors' guidelines for securitized loans.
- There are two main types of foreclosure procedures: judicial foreclosures and nonjudicial foreclosures. There are also redemption rights and deficiency judgments in some states which may affect the timing and severity of the foreclosure process.
- The federal government introduced several mortgage modification initiatives in 2009, including HAMP and HARP to mitigate foreclosure losses.
- A significant fraction of modified loans end up re-defaulting, whether it is a HAMP or a non-HAMP modification.
- Academics have documented some benefits as well as moral hazard effects of modifications.

PART VII

PORTFOLIO MANAGEMENT TOOLS AND TECHNIQUES

CHAPTER 29

MANAGING AGAINST THE BARCLAYS MBS INDEX

Prices and Returns

ERIC M. WANG AND BRUCE D. PHELPS

After reading this chapter you will understand:

- while using PSA settlement prices is an easy way to compute MBS returns, it can lead to jumps in month-to-date (MTD) returns unrelated to market movements.
- the motivation behind Barclays MBS Index's use of same-day settlement prices to calculate returns is to avoid these jumps.
- the same-day settlement assumption makes the MBS Index appropriate and useful for monitoring the total return performance of the mortgage market.
- same-day and PSA settlement prices can differ, move by different amounts, and in opposite directions from each other. However, the intra-month difference between the prices follows a predictable monthly pattern.
- MTD total returns using same-day settlement prices are generally much smoother than returns using PSA settlement prices. At any given point in the month, there can be a large difference between the two MTD returns.
- monthly total returns from the two settlement assumptions may not be equal, and significant return differences may persist, particularly in environments of elevated and volatile prepayments and large interest rate movements.

The Barclays Fixed-Rate MBS Index maps individual agency MBS pools to "annual aggregates" (or "generics"), according to program, coupon, and vintage. The index contains only these annual aggregates (about 320 as of June 2015) and has rules for calculating index prices and returns that may differ from what investors may use for their MBS holdings. This chapter describes the MBS index pricing and returns methodologies and highlights the price and return dynamics that result.[1]

MBS Index Prices and Returns: Overview

We begin with an overview of MBS Index prices and returns, examining the important issues in constructing the index.

The Importance of the MBS Index's Same-Day Settlement Assumption

The Barclays MBS Index has rules for calculating prices and returns that may differ from those that some MBS portfolio managers use for their MBS portfolios. In particular, the index calculates index prices assuming same-day settlement, whereas many portfolio managers rely on PSA prices that assume settlement at the next PSA settlement date which may be a month away or longer. This difference in settlement assumption can produce significant differences in prices. In fact, the index price for an annual aggregate can move by different amounts or even in the opposite direction from the underlying PSA price. In addition, the difference in settlement assumption can produce significant differences in the pattern of month-to-date (MTD) returns and in returns across months.

PSA prices are prices for a dollar of current face for settlement at the indicated PSA date. However, using PSA settlement date prices for an index raises two issues. First, other securities in the Barclays Global Family of Indices are priced assuming T+1 settlement. If PSA settlement were used for MBS, then a broader index (e.g., the US Aggregate) might contain securities with potentially very different settlement dates. Another difficulty with PSA settlement is that the settlement date can jump significantly from one day to the next, which, in turn, can cause large price and valuation jumps. For example, moving from the day before to the day of the switch in the PSA settlement month (t_{sw}, or "switch day") causes the time to settlement to lengthen by about a month. This affects valuation because the owner of the MBS at the end of the month is entitled to the principal paydown and full coupon, whereas an investor who acquires the security for PSA settlement in the following month is not. The investor who buys the security for settlement next month has an extra month to earn some return on the settlement value. Therefore, valuing an MBS today using next month's PSA settlement price is inaccurate because that price does not reflect the cash flows to be received by the investor who

[1] For simplicity, we assume the MBS index contains a single premium MBS passthrough annual aggregate. Although the following analysis remains applicable for discounts and par-priced securities as well, some of the results may have opposite signs.

acquires the security today. The PSA price typically drops on switch day because the net value of the following month's paydown and coupon exceeds the interest to be earned by holding onto cash for another month. Therefore, using PSA prices to value the position tends to produce a well-anticipated drop in market value of the position when t_{sw} is reached.

These problems explain why the Barclays MBS Index assumption of same-day settlement is so valuable. Daily index returns attempt to measure the change in value of an index holding. If you bought the index position on day T and sold it on day T+1, what was your market gain or loss? Suppose day T were the day before t_{sw} and PSA settlement was used. Due to the PSA drop, there would tend to be a negative daily return. But this negative return would be due to settlement taking place in the following month, not due to any spread or term structure movements. The index assumption of same-day settlement avoids these issues. The MBS Index price and market value calculations reflect the value of the position, assuming you buy or sell the position on that day for cash, which makes Barclays MBS Index returns useful and logically consistent. However, despite the usefulness of the same-day settlement assumption, there are some drawbacks.

First, same-day settlement can cause confusion for investors accustomed to using PSA prices, which are widely observable in the marketplace, for performance calculations. For example, index pricing beyond t_{sw} cannot simply use the present value of the PSA price. The index price must also be adjusted for the cash flows that the buyer today, as opposed to the buyer for settlement next month, is entitled to receive. A second drawback of same-day settlement is related to the first: sometimes the cash flow adjustments must be estimated. For example, at t_{sw}, the index needs to estimate how much a dollar in current face today will not survive to the following month and must instead be priced at the present value of par. However, the paydown factor is not published until the following month. As a result, the index has to estimate next month's paydown factor and, hence, next month's survival rate (the percentage of this month's current face that survives into next month). Which of the many possible estimators for the paydown should be used? To make index pricing as model-independent as possible, the index uses last month's survival rate until the index factor date, t_f, when it is replaced by this month's actual survival rate.

While model-independent, this method of survival factor estimation can introduce distortions. The first is related to the change in index price calculation that occurs on t_{sw}. Before t_{sw}, the index implicitly uses the market's estimate of how much current face will survive into next month which is embedded in this month's PSA price. However, from t_{sw} on, the PSA price for settlement next month does not incorporate the survival rate to be published next month. Consequently, the index must provide its own estimate which is last month's survival rate. In a rapidly changing interest rate environment, the market's estimate of survival at t_{sw} may differ significantly from last month's survival rate. In that case the switch from the market's estimate to last month's survival rate may cause a jump in the index price that has nothing to do with market movements. Another jump may occur later in the month (at t_f) when the index begins using this month's survival rate for this month's paydown and as the estimator of next month's survival rate.

	PSA Settle	Same-day Settle
Pros	Familiarity. PSA settle is a market convention for many MBS positions	Consistency. Other Barclays indices are priced assuming T+1 settle
	Simplicity. Obtaining and using PSA settle prices require little processing.	Accuracy. Returns reflects changes in market conditions only and are not influenced by arbitrary changes in settlement date
Cons	Returns may jump in the absence of spread or term structure movement.	Complexity. Same-day settle prices must be derived from PSA-settle prices
	Inaccuracy. Pricing after t_{sw} reflects entitled cashflows for next month's settlement, not this month.	Paydown factors must be estimated, using previous month's values
Consequences	P^{psa} and P^{index} may differ and move in opposite directions. Returns may diverge for an extended period of time.	

FIGURE 29.1 Pros and cons of the different settlement assumptions for MBS pricing

Source: Barclays Research

Figure 29.1 provides a summary of the qualitative differences between the two settlement assumptions.

P^{index} versus P^{psa}

Suppose it is the last day of month A and the PSA price is 103. PSA settlement is for the following month, month B. What is the price for a dollar of current face for settlement today? The 103 price does not reflect the paydown and full coupon you would be entitled to receive (next month) if you settle today. To arrive at today's same-day settlement price you would need to estimate, Š, the portion of the dollar of current face that would survive into month B. (The mark at the top of the symbol Š indicates that it is an estimate of the actual survival rate S.) Š is $\leqq 1$. For an MBS with PSA price 103, Š might be 0.96. This surviving current face amount is then priced at the present value of the PSA "dirty price" (P^{psa} + AI^{psa}) which equals the PSA "clean price," P^{psa}, plus accrued interest, AI^{psa} (say, 0.25), at the PSA settlement date. The remaining non-surviving amount, 1 – Š, is priced at the present value of par. You will also be entitled to a full month of coupon on the dollar of current face. However, since you are buying for settlement at the last day of the month, the accrued interest is roughly equal to the present value of a month of coupon, and therefore the same-day settlement *clean* price would be approximately:[2]

$$P^{index} \approx \check{S} \times PV[P^{psa} + AI^{psa}] + (1 - \check{S}) \times PV[100] \tag{1}$$

$$P^{index} \approx (0.96) \times PV[103.25] + (0.04) \times PV[100] = 103.12$$

[2] We use the notation $PV[P^x(t)]$ to represent the present value on day t of the price P for settlement at time x.

Note that the index price recognizes that only a fraction Š of current face survives into the following month. Consequently, the sensitivity of the index price to changes in the PSA market price is scaled down by Š. The market value of the position, V^{index}, is found by adding back the (approximately) full month of accrued interest (Cpn). On the last day of the month:

$$\begin{aligned} V^{index} &= P^{index} + Cpn \\ V^{index} &\approx \check{S} \times PV[P^{psa} + AI^{psa}] + (1 - \check{S}) \times PV[100] + Cpn \end{aligned} \tag{2}$$

On the first day of month B, you own Š (still an estimate) of current face. At what price could you sell it for settlement today? Answer: $PV[P^{psa} + AI^{psa}]$. Assuming that $[P^{psa} + AI^{psa}]$ is unchanged since the last day of month A, what is P^{index} on the first day of month B? We can see that the index price "jumps up." Noting that accrued interest equals zero on the first day of the month, we have:

$$P^{index} \approx PV[P^{psa} + AI^{psa}] = 103.25 \tag{3}$$

On the first day of month B, the value of the index position equals the surviving fraction, Š, of the initial current face valued at the index price, P^{index}, plus the non-surviving fraction, 1 – Š, of the initial current fact valued at the present value of par. Since the position was holder of record on the last day of the previous month, it is entitled to receive the full monthly coupon, Cpn.

$$\begin{aligned} V^{index} &\approx \check{S} \times P^{index} + (1 - \check{S}) \times PV[100] + Cpn \\ V^{index} &\approx \check{S} \times PV[P^{psa} + AI^{psa}] + (1 - \check{S}) \times PV[100] + Cpn \end{aligned} \tag{4}$$

Ignoring the one-day present-value effect, we see from equation (4) that the market value of the index position has not changed, as equation (4) is identical to equation (2). Note that the current face held in equation (4) is less than the amount in equation (2). The total return over month-end is zero which is consistent with the assumption that $[P^{psa} + AI^{psa}]$ is unchanged. Although the index reports a negative paydown return on the first day of the month, the total return is zero due to a positive index price change. The "jump up" in the index price equals the "paydown loss" which is the difference between the month-end index price and par, multiplied by one minus the survival factor Š.

While equation (1), the index price at the end of the month, requires an estimate of next month's (i.e., month B's) survival rate, equation (3), the index price at the beginning of the month, does not. Since the market's estimate of month C's survival rate is reflected in month B's PSA price, the index price at the beginning of the month implicitly uses the market's estimate of the following month's survival rate. On this month's t_{sw}, the change from the market's estimate of next month's survival rate to using last month's survival rate as the estimate can cause jumps in the index price.

Equation (4) also shows that the index value does not increase with daily accrued interest. The index value is the present value of the future settlement price (i.e., the full PSA price) plus the estimated paydown and known full coupon. The full index value includes the value of the future coupon payments. The index reports a *clean* price, which subtracts off the MTD accrued, and a separate MTD accrual so the daily decrease in the clean price and daily increase in accrued cancel each other. The only daily accrual experienced by the market value of the index position is the present-value accrual based on short-term LIBOR.

TR^{index} versus TR^{psa}

Until the paydown factor is published early in month B, the manager using PSA settlement prices accrues coupon based on the current face amount held at month-end A. As the PSA price for settlement in month B fluctuates, the manager calculates a gain or loss of market value, and thus price return, by multiplying the change in the PSA price by the dollar of current face. On t_{pub}, the day the agencies publish the paydown factors, the manager recognizes a paydown gain/loss by marking down his current face holding by the paydown amount and simultaneously crediting his cash receivables. The manager also writes down his MTD accrued interest to reflect coupon accrual on S dollars of current face ($S \leqq 1$). At the time of paydown recognition, the market value of the position jumps (ignoring any change in the PSA price on the day). Thereafter, the manager tracks accrued interest based on the reduced current face amount and calculates a price return by multiplying the change in the PSA price by S.

On day t_{sw}, the manager prices S units of current face at the new (and typically lower) PSA price. This causes the market value of the position to jump (even if the market is unchanged that day). From t_{sw} until the end of the month, the manager calculates price return by multiplying the change in the PSA price by S.

The manager calculates returns by dividing the market value at the end of the period (including any cash received) by the market value at the beginning of the period. At month-end, the manager's total monthly change in market value is the sum of three components:

1. accrued coupon on S dollars of current face;
2. the gain or loss of market value found by multiplying the monthly change in the PSA price by S; and
3. the paydown gain/loss recorded when the manager reduced current face holdings to S.

If there is no change in the PSA price (excluding the drop on t_{sw}), then the pattern of MTD returns (TR^{psa}) resembles the saw-tooth-shaped dashed line in Figure 29.2. The shape reflects that components of returns are recognized at different times during the month.

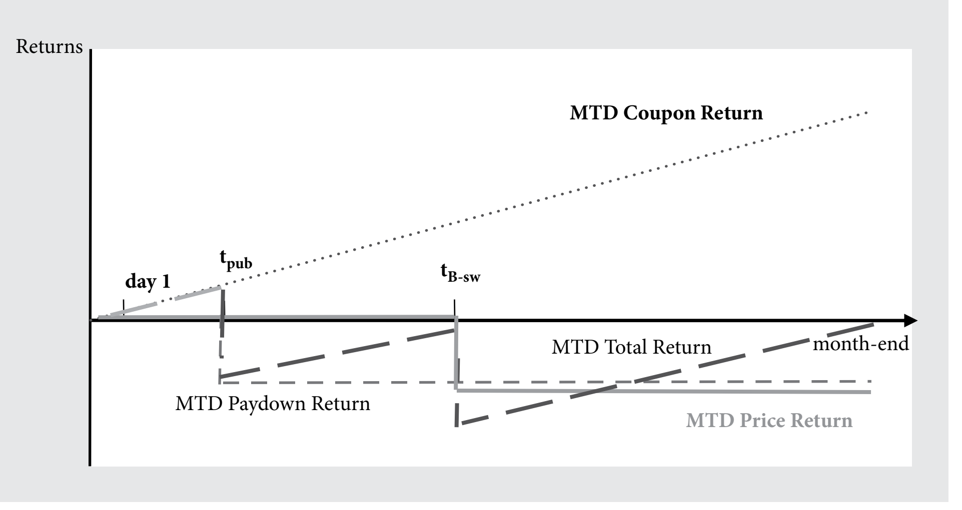

FIGURE 29.2 Stylized MTD PSA return dynamics (TR^{psa})

Source: Barclays Research

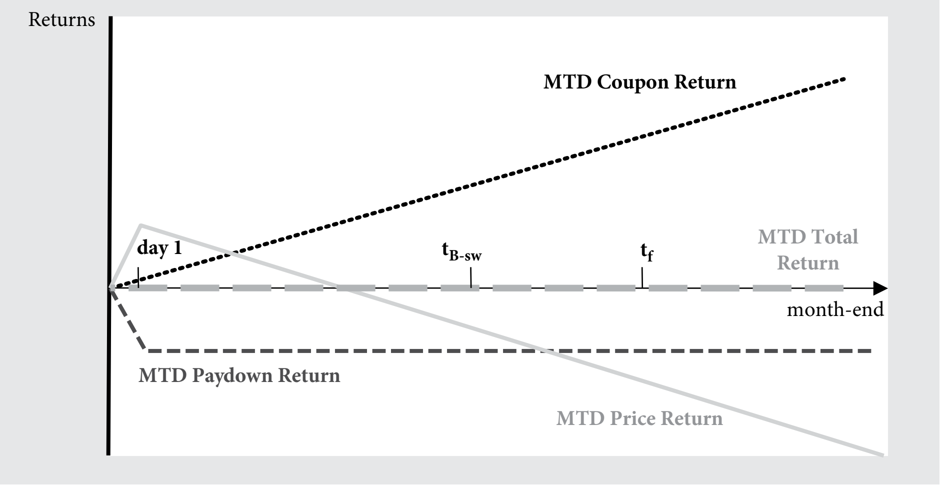

FIGURE 29.3 Stylized MTD index return dynamics (TR^{index})

Source: Barclays Research

MTD index returns (TR^{index}), using same-day settlement prices, exhibit a very different and smoother pattern (Figure 29.3). On the first day of the month, the index reduces its current face holding from a dollar to the estimated surviving portion Š (recall equation (4) above). The index records a negative paydown return which is offset by a positive index price return so that the total return is zero. As the PSA (and, hence, the index) price fluctuates, the index records a gain or loss of market value by multiplying the change in the index price by Š.

From the first of the month to the PSA switch date, the index price is based on the full PSA price. Since the PSA settlement date is fixed, the full PSA price and the market value of the position do not accrue any daily coupon. Consequently, assuming no changes in the market clean PSA price, the index price is unchanged, except for the present-value effect which causes the full index price to increase at LIBOR. The index convention is to subtract MTD accrued interest, AI(t), from the index price and report a MTD accrued coupon value. Since the clean index price declines as the MTD accrued interest increases, combining the two produces a zero net effect on the index position value.

Because of same-day settlement there should be no anticipated discrete changes in market value. If there were an anticipated drop, who would buy the security the day before? For example, the incorporation of month B's paydown factor should not be expected to produce a change in the market value of the index position. This is because the index anticipated this paydown at the end of month A.[3]

Changes in Index Prices and Returns on the PSA Switch Date (t_{sw})

On switch day, t_{sw}, the index prices its $\check{S}$ units of current face using next month's PSA price. However, in contrast to PSA settlement pricing, the same-day settlement assumption recognizes that only a fraction of the $\check{S}$ dollars[4] of current face will survive to the following month and needs to be priced at the present value of next month's PSA price. The non-surviving portion of the $\check{S}$ units of current face is priced at the present value of par. Also, a full month of coupon accrual must be added. Unlike PSA returns, there is no discrete move in the MTD index returns due solely to the change in the PSA settlement month.

On t_{sw} the index recognizes that a portion, $(1 - \check{S})$, of the $\check{S}$ units of current face that has survived into this month will not survive into the next. The index prices this $\check{S} \times (1 - \check{S})$ of non-surviving current face at the present value of par. The $(1 - \check{S})$ units of current face that did not survive into this month are also priced at par. Thus, the index prices a total of $(1 - \check{S}) + \check{S} \times (1 - \check{S}) = 1 - \check{S}^2$ units of current face at par and prices $\check{S}^2$ units of current face at the present value of the PSA price. In contrast, PSA settlement returns price only $1 - \check{S}$ of current face at par. In effect, after t_{sw} the MTD market value change in the index position is driven by the change in the PSA price scaled by $\check{S}^2$, but the PSA-based position is scaled only by $\check{S}$. This is a difference between the two returns and is a reason why they may differ. In an environment of increasing PSA prices and declining values of $\check{S}$, index returns are likely to lag PSA-based returns.

[3] This is not precisely correct. At month-end A, the index uses an estimated (i.e., last month's) paydown factor, which may differ from the market's expected factor used to price the drop in month B.

[4] The index must estimate S (i.e., this month's survival rate) in addition to estimating the portion of S that will survive into next month (next month's survival rate). As discussed, the index uses the most recently published survival rate as the estimator for all estimated survival rates. On the switch date, the index price uses last month's survival rate, which is known, as the estimate of the survival rates for the current month and for next month.

After t_{sw} in the current month:

$$P^{index} \approx \check{S} \times PV[P^{psa} + AI^{psa}] + (1 - \check{S}) \times PV[100] + PV[Cpn] - AI(t) \tag{5}$$

$$\begin{aligned} V^{index} &\approx \check{S} \times \{P^{index}\} + (1 - \check{S}) \times PV[100] + PV[Cpn] + \check{S} \times AI(t) \\ &\approx \check{S} \times \left\{ \check{S} \times PV[P^{psa} + AI^{psa}] + (1 - \check{S}) \times PV[100] + PV[Cpn] \right\} \\ &\quad + (1 - \check{S}) \times PV[100] + PV[Cpn] \end{aligned} \tag{6}$$

Changes in Index Prices and Returns on the Pool Factor Date (t_f)

On the sixteenth business day of the month, t_f (index "factor day"), the index incorporates paydown factor data published in the current month by replacing the estimated value of this month's survival rate, and using the published data to estimate next month's survival rate.

To illustrate the two ways this replacement affects index returns, suppose that this month's actual survival rate (S) is lower than the estimate. First, the current index price will drop to reflect that less current face than previously expected (since t_{sw}) is now expected to survive to next month. Second, less current face has survived into the current month than was previously assumed. The paydown return must decline because our calculation at the beginning of the month underestimated this month's paydown. The MTD paydown return is decreased by the difference between the estimated and actual survival rate multiplied by the paydown loss amount. Together, these two effects reduce the MTD index returns on t_f. If this month's survival rate is higher than last month's, the opposite occurs.

After t_f, index returns are driven by the change in P^{psa} scaled by $S \times S$. Assuming there is little change in P^{psa} (excluding the drop on t_{sw}) and that survival rates do not change and are accurately estimated by the market, and LIBOR is low and constant, then the index's pattern of MTD returns will be the horizontal dashed line in Figure 29.3. In this case, MTD index total returns are very smooth, as the index accounts for the estimated paydown, a full month of coupon, and the PSA price drop simultaneously on the PSA switch date. Figure 29.4 summarizes the intra-month differences between P^{psa} and P^{index}.

Comparing TR^{index} and TR^{psa}

The two return series, TR^{psa} and TR^{index}, will exhibit different patterns over a month. Figure 29.5 illustrates the MTD total return difference ($TR^{difference} = TR^{psa} - TR^{index}$). Assuming MTD TR^{index} is zero, Figure 29.5 shows conceptually how the performance for managers who calculate their MTD performance using PSA prices will differ from their index benchmark. Not only will the manager's TR^{psa} differ from TR^{index} during the

Date	PSA Settle	Same-day Settle
During the month	Accrued coupon return lifts total return	Accrued coupon return offset by clean price decline
t_1: Day 1		Positive price return offset by negative paydown return, because index adjusts factors on Day 1
Before factor publication	Coupon accrual and price return based on \$1 current face	Coupon accrual and total return based on surviving factor S (estimated based on prior month's prepay)
t_{pub} : paydown factors published	Paydown loss due to reduction of current face to S. Hereafter total return driven by $S \times \Delta P^{psa}$	
t_{sw}: change in PSA-settlement month	Price loss due to PSA price drop	Hereafter total return driven by S^2 unit of PSA price
t_f : Index factors updated		Price *and* paydown adjustment based on actual vs. estimated paydown

FIGURE 29.4 P^{psa} and P^{index} differences over a month for a single premium index aggregate

Source: Barclays Research

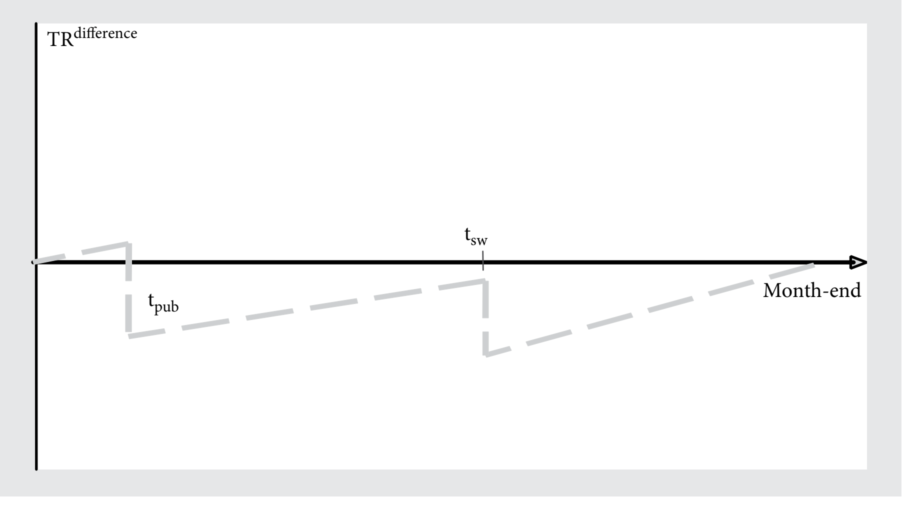

FIGURE 29.5 Stylized MTD total return difference ($TR^{difference} = TR^{psa} - TR^{index}$) dynamics

Source: Barclays Research

month, but the two returns may not be equal for the month as a whole. As mentioned, monthly TR^{index} is driven by the change in the PSA price scaled by $S \times S$, whereas monthly TR^{psa} is driven by the change in the PSA scaled only by S. In other words, in an environment of rising paydowns (i.e., falling S values) and rising PSA prices, TR^{psa} is likely to be greater than TR^{index}. In other circumstances, TR^{psa} may be less than TR^{index}.

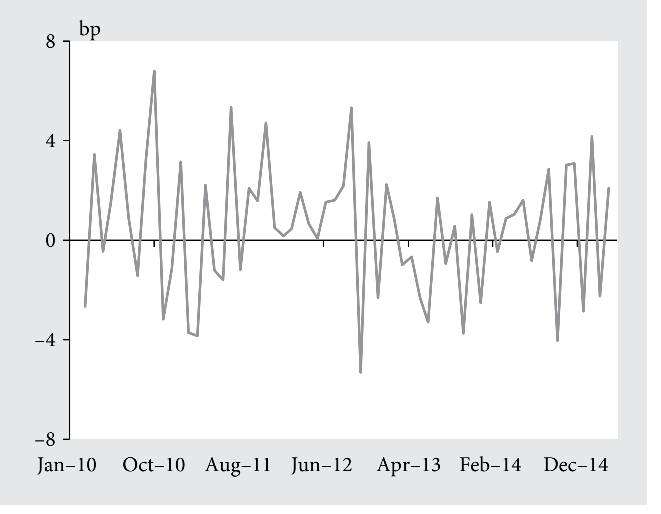

FIGURE 29.6 Monthly $TR^{difference}$ for the MBS index, February 2010–March 2015, in bps

Source: Barclays Research

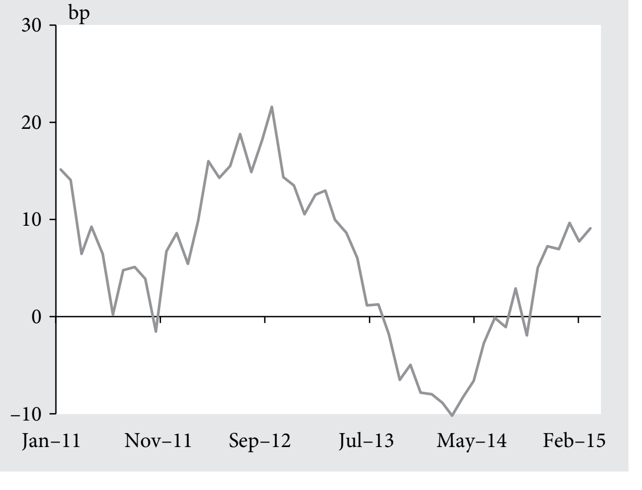

FIGURE 29.7 Twelve-month cumulative $TR^{difference}$ for the MBS index, January 2011–March 2015, in bps

Source: Barclays Research

Figure 29.6 shows the monthly $TR^{difference}$ for February 2010 to March 2015. Monthly return differences can be meaningful. Depending on the market environment, the return differences can accumulate and persist for many months. Figure 29.7 shows the 12-month cumulative $TR^{difference}$ using data in Figure 29.6.

The remainder of this chapter provides detailed index price and return calculations that will help investors replicate index pricing and return methodologies. We will often refer back to the figures above. The chapter concludes with a detailed example.

MBS Index Prices (P^{index})

P^{index} and P^{psa} represent prices for different cash flows for settlement at different times. As a result, on a given day, the two prices are not necessarily equal, can change by different amounts, and can change in different directions. P^{index} is the clean price for $1 of current face for settlement the same day. In contrast, P^{psa} is the price on that day for $1 of current face for settlement on a future PSA settlement date.

"The first day of the month" refers to the first business day of the month, and "the last day of the month" refers to the last business day of the month. In addition, the phrase "the beginning of the month" refers to the last business day of the previous month. For MBS Index pricing, there are seven key dates during the month (call it month A). See Figure 29.8:

- $\mathbf{t_{A\text{-}mb}}$: The beginning of month A (or the last day of the month prior to month A).
- $\mathbf{t_{A\text{-}1}}$: The first day of month A.
- $\mathbf{t_{A\text{-}pub}}$: Although not important for the index, $t_{A\text{-}pub}$ is when the agencies publish updated factors. Factors are typically published from the fourth to the eighth business day.
- $\mathbf{t_{A\text{-}sw}}$: "Switch Day": The PSA settlement switch date in month A when the index begins to calculate prices using the PSA price for settlement on the PSA settlement date in the following month (i.e., month B).[5]
- $\mathbf{t_{A\text{-}psa}}$: The PSA settlement date in month A.
- $\mathbf{t_{A\text{-}cf}}$: The date in month A when cash flows are assumed to be received (depends on the MBS program). These cash flows belong to the holder of record on $t_{A\text{-}mb}$.
- $\mathbf{t_{A\text{-}f}}$: "Factor Day": The index factor date is the sixteenth business day of the month when the finalized paydown factors for the month are incorporated in index pricing and return calculations. On this day, the actual paydown factors replace all estimated factors.
- $\mathbf{t_{A\text{-}me}}$: The last day of month A (and also referred to as the beginning of month B, $t_{B\text{-}mb}$).

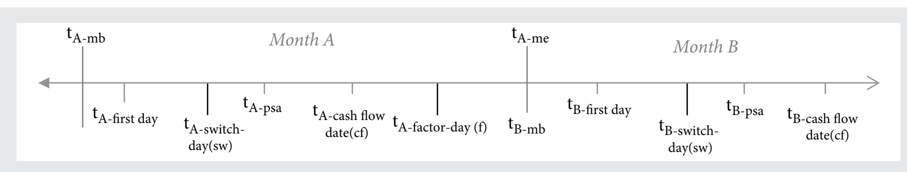

FIGURE 29.8 Important MBS index dates during a month

Source: Barclays Research

[5] The Index currently defines $t_{A\text{-}sw}$ as two business days prior to the PSA settlement day in month A for the first agency program that switches settlement months. The index changes the PSA settlement month for all annual aggregates, irrespective of program, on this date.

Calculating $P^{index}(t)$

Let $P^{index}(t)$ denote the index clean price on day t and let $P^{A\text{-}psa}(t)$ denote the PSA price on day t for settlement on day $t_{A\text{-}psa}$. Similarly, $P^{B\text{-}psa}(t)$ denotes the PSA price on day t for settlement on day $t_{B\text{-}psa}$, and so on. Let $PV[F^s(t)]$ denote the present value on day t of a cash flow F to be received on day s.[6]

Given a day, t, in month A, and $t < t_{A\text{-}sw}$, $P^{index}(t)$ is calculated by discounting $P^{A\text{-}psa}(t)$ from $t_{A\text{-}psa}$ back to index pricing date t. More precisely, in month A up to $t_{A\text{-}sw}$ we have:

$$P^{index}(t) + AI(t) = PV[P^{A-psa}(t) + AI^{A-psa}(t)] \quad \text{for} \quad t_{A-1} \le t < t_{A-sw}$$

where AI(t) denotes accrued interest at time t and $PV[P^{A\text{-}psa}(t) + AI^{A\text{-}psa}(t)]$ denotes the present value on day t of the full PSA price for settlement at $t_{A\text{-}psa}$. The discount rate used is short-term LIBOR. Rearranging, we get equation (7):

$$P^{index}(t) = PV[P^{A-psa}(t) + AI^{A-psa}(t)] - AI(t) \quad \text{for} \quad t_{A-1} \le t < t_{A-sw} \tag{7}$$

For reasonable levels of LIBOR, $P^{index}(t)$ is likely to be greater than $P^{A\text{-}psa}(t)$ on the first day of the month and up to $t_{A\text{-}sw}$ since $AI^{A\text{-}psa}(t)$ is greater than AI(t).[7] AI(t) is set to zero on the first day of the month and increases during the month.

What happens to P^{index} through the month, assuming $P^{A\text{-}psa}$ remains constant? The present-value effect of discounting from $t_{A\text{-}psa}$ to the present declines as we get closer to $t_{A\text{-}psa}$. However, the other component of the carry relationship is the subtraction of AI(t), which grows steadily with t. If $P^{A\text{-}psa}(t)$ remains unchanged, the full index price grows by LIBOR, not by the accrued coupon. Although the index does recognize a daily coupon accrual, this accrual is offset by a change in the clean index price. On the first day of month A, when AI(t) = 0, $P^{index}(t)$ includes the full accrued on the settlement date, $AI^{A\text{-}psa}(t)$, discounted to the present. As AI(t) grows daily, $P^{index}(t)$ decreases or increases depending on whether the coupon rate is roughly greater or less than LIBOR.

On $t_{A\text{-}sw}$, the index begins to use $P^{B\text{-}psa}(t)$ to calculate $P^{index}(t)$. The settlement dates for $P^{index}(t)$ and $P^{B\text{-}psa}(t)$ are in separate months. If $P^{index}(t)$ assumes settlement in month A and $P^{B\text{-}psa}(t)$ assumes settlement in month B, then the difference between $P^{index}(t)$ and $P^{B\text{-}psa}(t)$ must reflect the different cash flows to be received, some of which are not yet known and must be estimated.

On $t_{A\text{-}sw}$ the index recognizes that only a (unknown) fraction, S^B, of current face will be available for settlement at $t_{B\text{-}psa}$. Let $\check{S}^B$ represent the estimated fraction of current face at the end of month A that survives into month B. Consequently, the portion $\check{S}^B$ of the current face is valued on $t_{A\text{-}sw}$ using $PV[P^{B\text{-}psa}(t_{A\text{-}sw}) + AI^{B\text{-}psa}(t_{A\text{-}sw})]$. The non-surviving portion, $(1 - \check{S}^B)$, to be paid at par at $t_{B\text{-}cf}$, has a present value of $PV[100^{B\text{-}cf}(t_{A\text{-}sw})]$, where

[6] $PV[P^{A\text{-}psa}(t)] = P^{A\text{-}psa}(t)/[(1+(r/360))\text{^}(t_{A\text{-}psa} - t)]$.

[7] Note that $AI^{A\text{-}psa}(t)$, unlike AI(t), remains constant in Month A.

$100^{B\text{-}cf}$ denotes a cash flow of 100 to be received on day $t^{B\text{-}cf}$. In addition, the current face position at $t_{A\text{-}sw}$ is entitled to receive a coupon payment at $t_{B\text{-}cf}$ that has a present value of $PV[Cpn^{B\text{-}cf}(t_{A\text{-}psa})]$, where $Cpn^{B\text{-}cf}$ denotes a cash flow of size Cpn to be received on day $t_{B\text{-}cf}$.[8] Consequently, on $t_{A\text{-}sw}$, equation (7) is replaced by:

$$\begin{aligned} P^{index}(t) = {} & (\text{portion, } \check{S}^B, \text{ that survives into month B}) \times PV[P^{B-psa}(t) + AI^{B-psa}(t)] \\ & + (\text{portion, } 1-\check{S}^B, \text{that will be paid off at par at } t_{B-cf}) \times PV[100^{B-cf}(t)] \\ & + PV[Cpn^{B-cf}(t)] - AI(t), \qquad \text{for } t_{A-sw} \le t < t_{A-me} \end{aligned} \tag{8}$$

On $t_{A\text{-}sw}$, S^B is unknown until $t_{B\text{-}f}$. Before $t_{B\text{-}f}$ the index uses the most recent survival rate as the estimator of S^B. In other words, on $t_{A\text{-}sw}$ the index uses the survival rate for the month before month A (call it month Z) as the estimator for S^B, since that is the latest one known. Later in the month, on day $t_{A\text{-}f}$, when S^A becomes known, the index will use S^A as the estimator for S^B.[9]

While equation (8) requires an estimate of month B's survival rate, equation (7), the formula for the index price for the first part of the month, does not. Equation (7) uses month A's PSA price. Thus the index price in the first part of month A implicitly uses the market's estimate of month B's survival rate. On and after $t_{A\text{-}sw}$, the index price is calculated from month B's PSA price, which does not reflect any estimate of month B's survival rate, so such an estimate must be included explicitly.

Does $P^{index}(t)$ "Jump" on the PSA Switch Date, ($t_{A\text{-}sw}$)?

On a given day, the PSA price for settlement in month B is usually lower than the PSA price for settlement in month A. One might expect the index price to drop on $t_{A\text{-}sw}$. To see why it does not, recall that $\check{S}^B$ is the index's estimate of S^B and on $t_{A\text{-}sw}$ the index sets $\check{S}^B$ equal to S^Z, the most recently known survival rate (note: $t_{A\text{-}f}$ follows $t_{A\text{-}sw}$). From equation (8) we have:

$$\begin{aligned} P^{index}(t_{A-sw}) + AI(t_{A-sw}) = {} & S^Z \times PV[P^{B-psa}(t_{A-sw}) + Al^{B-psa}(t_{A-sw})] \\ & + (1-S^Z) \times PV[100^{B-cf}(t_{A-sw})] + PV[Cpn^{B-cf}(t_{A-sw})] \end{aligned} \tag{9}$$

[8] The term Cpn refers to the annual coupon rate ÷ 12.

[9] On and after $t_{A\text{-}f}$, S^B is estimated using month A's known 1-month SMM, WAC, and WAM:

$$S = (1-(WAC/1200)/(1-(1+WAC/1200)^{-WAM}) + WAC/1200)(1-SMM)$$

From t_{sw} to $t_{A\text{-}f}$, before month A's factor data is recognized, $\check{S}^A$ uses month Z's S^Z value. $\check{S}^B$ uses month Z's data and adjusts WAM by −1 month. Since $\check{S}^A$ and $\check{S}^B$ are nearly identical to S^Z, we use S^Z in the equations.

Equation (9) is similar to the "dollar roll" calculation and shows that when switching to next month's PSA price, the index recognizes the present value of the additional cash flows that the same-day settlement buyer is entitled to receive. These are the cash flows that create a difference between $P^{A\text{-}psa}(t_{A\text{-}sw})$ and $P^{B\text{-}psa}(t_{A\text{-}sw})$. Thus, if S^Z roughly equals the market's expectation of month B's survival rate (call this expectation $\check{S}^{B\text{-}exp}$) and the roll is at "fair value," then there will be no jump in $P^{index}(t_{A\text{-}sw})$ due to the switch from $P^{A\text{-}psa}(t_{A\text{-}sw})$ to $P^{B\text{-}psa}(t_{A\text{-}sw})$, despite the difference between the two PSA prices.

However, last month's prepayments are not always good estimators of next month's prepayments. For example, in a declining interest rate environment, prepayments may be accelerating so that $S^Z > \check{S}^{B\text{-}exp}$. This is likely to produce an upward jump in $P^{index}(t_{A\text{-}sw})$, all else equal.[10]

What Happens to $P^{index}(t)$ on the Final Paydown Factor Date, $(t_{A\text{-}f})$?

On $t_{A\text{-}f}$, factor day, the index uses the actual value of S^A. Since $t_{A\text{-}sw}$ the index had been using S^Z to estimate paydowns for month B. What happens to $P^{index}(t_{A\text{-}f})$ when there is a discrepancy between S^A and S^Z? At $t_{A\text{-}f}$ the index price is given by:

$$\begin{aligned} P^{index}(t_{A-f}) = S^A \times PV[P^{B-psa}(t_{A-f}) + AI^{B-psa}(t_{A-f})] \\ +(1-S^A)\times PV[100^{B-cf}(t_{A-f})] + PV[Cpn^{B-cf}(t_{A-f})] - AI(t_{A-f}) \end{aligned}$$

If this month's prepayment speeds are faster than last month's, we have $S^Z > S^A$. Consequently, using S^A as the new $\check{S}^B$ will cause a drop in index prices for a premium MBS:

$$P^{index}(t_{A-f}\,|S^A) < P^{index}(t_{A-f}|S^Z)$$

Note that the impact of the updated faster (slower) factors can cause the index price to drop (rise) even if the PSA price is higher (lower) than it was on the previous business day.

Assuming $S^Z > S^A$ and unchanged PSA prices, the index will produce a negative price return for the day. In addition, there will be an increase in the MTD negative paydown return, as the previous MTD paydown return was based on an assumed higher survival rate. Overall, the index will show a negative daily total return even if the PSA price is flat or even higher.

[10] Note that while it may be the case that $S^Z > \check{S}^{B\text{-}exp}$, for technical reasons the roll may be trading "special." This effect could produce a downward jump in $P^{index}(t_{A\text{-}sw})$. For purposes of discussing index pricing, we will assume that $\check{S}^B = \check{S}^{B\text{-}exp}$ and that the roll is at "fair value."

At month-end, $t_{A\text{-me}}$,

$$P^{index}(t_{A-me}) = S^A \times PV[P^{B-psa}(t_{A-me}) + AI^{B-psa}(t_{A-me})] + (1-S^A) \times PV[100^{B-cf}(t_{A-me})] + PV[Cpn^{B-cf}(t_{A-me})] - Cpn \qquad (10a)$$

What Happens to $P^{index}(t)$ on the First Business Day of the Following Month ($t_{B\text{-}1}$)?

How does $P^{index}(t)$ change over month-end? First, we rewrite equation (10a) recognizing that $t_{A\text{-me}}$ and $t_{B\text{-mb}}$ are the same day:

$$\begin{aligned} P^{index}(t_{B-mb}) = {} & PV[P^{B-psa}(t_{B-mb}) + AI^{B-psa}(t_{B-mb})] \\ & -(1-S^A) \times \left(PV[P^{B-psa}(t_{B-mb}) + AI^{B-psa}(t_{B-mb})] - PV[100^{B-cf}(t_{B-mb})] \right) \\ & + PV[Cpn^{B-cf}(t_{B-mb})] - Cpn \end{aligned} \qquad (10b)$$

By side-by-side comparison with equation (7), the index price undergoes the following changes on $t_{B\text{-}1}$:

1. the paydown loss term, $-(1 - S^A) \times (PV[P^{B\text{-}psa}(t_{B\text{-}mb}) + AI^{B\text{-}psa}(t_{B\text{-}mb})] - PV[100^{B\text{-}cf}(t_{B\text{-}mb})])$, disappears;
2. the present value of this month's coupon, $PV[Cpn^{B\text{-}cf}(t_{B\text{-}mb})]$, is no longer added; and
3. the accrued interest is reset to zero.

The first two changes derive from the index's same-day settlement assumption because an investor acquiring the security on the first day of month B will not receive month B's coupon and paydown.[11] The third change results from resetting the accrued on the first day of the month from Cpn to zero.

Dropping the paydown loss term usually has the most effect on the index price on $t_{B\text{-}1}$. For a premium security, the disappearance of the paydown loss term makes the index price jump up. In fact, the index price may increase on the first day of the month even if the PSA price decreases that day. Similarly, the index price of a discount security can drop on the first day even if the PSA price increases. Although this phenomenon is often a source of confusion, it is a logical consequence of the index's same-day settlement assumption.

As will be shown, index pricing produces smoother returns and market values than those using PSA pricing. Portfolio managers who use PSA prices experience a paydown return on the day the prepayment factors are published. Only then do managers adjust their current face holdings. Later, they experience a "drop" in the price on switch day.

[11] By "month N's cash flow/coupon/paydown" we mean the cash flow received in month N. Since all index aggregates' delays are less than 30 days, the accrual period for this cash flow is in month N−1.

These events impact market value, and consequently their MTD total returns. Although the index recognizes a paydown return on t_{B-1}, there is also a jump in price producing a price return that offsets the paydown return on the same day. Also, the index price offsets the effect of the "drop" on switch day by recognizing month A's coupon and estimated paydown on the same day.

The following summarizes the index price equations:

Index Price Equations

$$P^{index}(t) = PV[P^{A-psa}(t) + AI^{A-psa}(t)] - AI(t) \;\; \text{for} \;\; t_{A-1} \le t < t_{A-sw} \tag{11}$$

$$\begin{aligned} P^{index}(t) &= \check{S}^{B} \times PV[P^{B-psa}(t) + AI^{B-psa}(t)] + (1-\check{S}^{B}) \times PV[100^{B-cf}(t)] \\ &\quad + PV[Cpn^{B-cf}(t)] - AI(t) \\ &= S^{Z} \times PV[P^{B-psa}(t) + AI^{B-psa}(t)] + (1-S^{Z}) \times PV[100^{B-cf}(t)] \\ &\quad + PV[Cpn^{B-cf}(t)] - AI(t) \;\; \text{for} \; t_{A-sw} \le t < t_{A-f} \end{aligned} \tag{12}$$

The value for $\check{S}^{B}$ changes from S^{Z} to S^{A} beginning at t_{A-f} through t_{A-me}:

$$\begin{aligned} P^{index}(t) &= S^{A} \times PV[P^{B-psa}(t) + AI^{B-psa}(t)] \\ &\quad + (1-S^{A}) \times PV[100^{B-cf}(t)] + PV[Cpn^{B-cf}(t)] - AI(t) \end{aligned} \tag{13}$$

Equation (13) can be used to generate the index price for the beginning of month B:

$$\begin{aligned} P^{index}(t_{B-mb}) &= S^{A} \times PV[P^{B-psa}(t_{B-mb}) + AI^{B-psa}(t_{B-mb})] \\ &\quad + (1-S^{A}) \times PV[100^{B-cf}(t_{B-mb})] + PV[Cpn^{B-cf}(t_{B-mb})] - Cpn \end{aligned} \tag{14}$$

Figure 29.9 presents a schematic of $P^{index}(t)$ versus $P^{psa}(t)$ over the course of two months from t_{A-1} to t_{C-1}. We assume the MBS is a premium passthrough with a hypothetical initial price of $P^{A-psa}(t_{A-1}) = 103.00$. Note that $P^{index}(t_{A-1})$ is greater than $P^{A-psa}(t_{A-1})$ even though the index price represents the discounted value of the PSA price. As discussed, $P^{index}(t_{A-1})$ is calculated using $[P^{A-psa}(t_{A-1}) + AI^{A-psa}(t_{A-1})]$, not $P^{A-psa}(t_{A-1})$ alone. Including the PSA settle accrued interest usually more than offsets the discounting effect.

Moving through month A, we assume that $P^{A-psa}(t)$ is constant at 103. Although $P^{A-psa}(t)$ is constant, $P^{index}(t)$ is not. Even though $P^{index}(t)$ would tend to increase since $PV[P^{A-psa}(t) + AI^{A-psa}(t)]$ is discounted over fewer and fewer days, growing accrued interest is subtracted from $PV[P^{A-psa}(t) + AI^{A-psa}(t)]$, causing $P^{index}(t)$ to decline overall.[12]

[12] The decline in $P^{index}(t)$ is not completely smooth because only trade days are shown. There will also be a small jump if, at the PSA switch date, the next month's PSA settlement date in the month is different than the prior month's PSA settlement date. In this case, the $AI^{psa}(t)$ will differ from one month to the next, which may cause a small jump in $P^{index}(t_{sw})$.

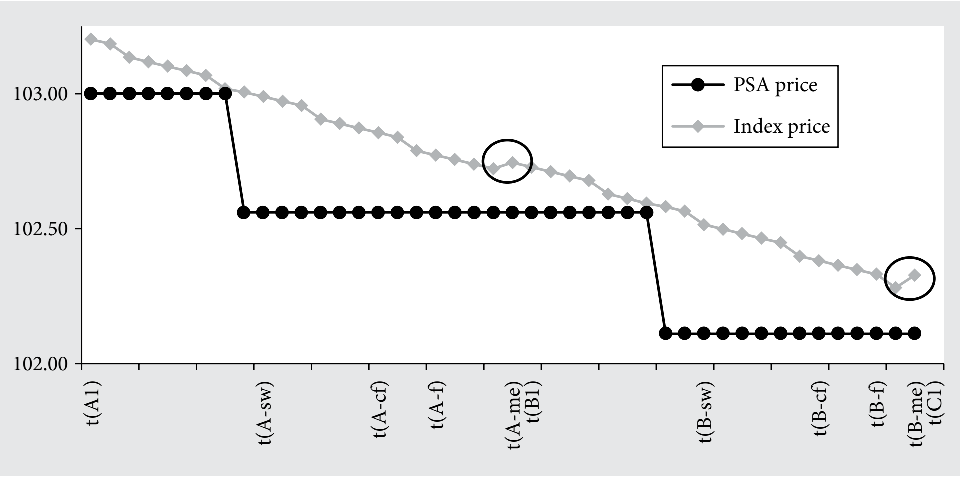

FIGURE 29.9 Comparison of $P^{index}(t)$ and $P^{psa}(t)$

Source: Barclays Research

At $t_{A\text{-}sw}$ PSA settlement moves from month A to month B. This produces the "drop" in $P^{psa}(t)$ (i.e., 103.00 – 102.56 = 0.44). For Figure 29.9, we assume that the drop is at "fair value." However, $P^{index}(t)$ declines only a little. Unlike $P^{psa}(t)$, whose assumed time until settlement changed by a month, the time until settlement date for $P^{index}(t)$ is unchanged (i.e., same day).

After $t_{A\text{-}sw}$, keeping $P^{B\text{-}psa}(t)$ constant at 102.56, $P^{index}(t)$ continues to decline due to the increase in accrued interest.

At $t_{A\text{-}f}$ the value for S^A becomes known. Until $t_{A\text{-}f}$ the index has been using S^Z as the estimate for $\check{S}^B$. Now we set $\check{S}^B$ equal to S^A. If S^A differs from the previous estimate, there may be a "jump" in $P^{index}(t)$ at $t_{A\text{-}f}$. If S^A is greater (less) than S^Z then the index price will jump up (down). In Figure 29.9, we assume S^A equals S^Z.

On the last day of the month, $t_{A\text{-}me}$, for the values of S^A and $P^{B\text{-}psa}(t_{A\text{-}me})$ in our example, $P^{index}(t_{A\text{-}me})$ remains greater than $P^{B\text{-}psa}(t_{A\text{-}me})$. At $t_{B\text{-}1}$ the index price jumps up (highlighted by the first small circle) to reflect that pricing a unit of current face for settlement at $t_{B\text{-}1}$ no longer includes a paydown component.

MBS Index Returns (TR^{index})

The composition of the MBS Index Returns Universe for the current month is set on the last business day of the prior month. The composition contains only the set of index-eligible annual aggregates and their current face amounts. The composition of the MBS Index Returns Universe determines the index returns throughout the coming month (month B). The current face amounts for each annual aggregate are determined on the final paydown factor date, $t_{A\text{-}f}$, in month A reflecting both paydowns that were reported in month A plus any new issuance.[13]

Month B MBS Index returns assume the index is the current face holder of record as of the last day of month A.

While the index price typically jumps on day $t_{B\text{-}1}$ the *value* of the Returns Universe does not. For the holder of record at the end of month A, the value of the current face position reflects that the security suffers a paydown in month B. This is why the formula for the index price at the end of the month includes an estimated survival rate for month B. A current face position acquired from day $t_{B\text{-}1}$ on, however, is free of the paydown in month B. Therefore, on day $t_{B\text{-}1}$, the index price formula switches from equation (14) to equation (11), causing the index price to jump.

To value the Returns Universe on any day in month B, the index values all surviving current face from positions held at the end of the prior month plus any cash flow to be received in month B as the index was holder of record at the end of month A. The value, V(t), of a $1 current face position in the Returns Universe is:

$$\begin{aligned} V(t) &= \check{S}^{B} \times PV[P^{B-psa}(t) + AI^{B-psa}(t)] + (1-\check{S}^{B}) \times PV[100^{B-cf}(t)] \\ &\quad + PV[Cpn^{B-cf}(t)] \qquad \text{for } t_{B-mb} \le t < t_{B-sw} \end{aligned} \tag{15}$$

Recall, at the beginning of month B, the estimator for $\check{S}^B$ is S^A. Equation (16) shows the price of a $1 of current face acquired on or after the PSA settlement switch date:

$$\begin{aligned} V(t) &= \check{S}^{B} \times \left\{P^{index}(t) + AI(t)\right\} + (1-\check{S}^{B}) \times PV[100^{B-cf}(t)] + PV[Cpn^{B-cf}(t)] \\ &= \check{S}^{B} \times \left\{\check{S}^{C} \times PV[P^{C-psa}(t) + AI^{C-psa}(t)] + (1-\check{S}^{C}) \times PV[100^{C-cf}(t)] \right. \\ &\quad \left. + PV[Cpn^{C-cf}(t)]\right\} + (1-\check{S}^{B}) \times PV[100^{B-cf}(t)] + PV[Cpn^{B-cf}(t)] \\ &\text{for } t_{B-sw} \le t < t_{B-f} \end{aligned} \tag{16}$$

Recall, until $t_{B\text{-}f}$, the estimator for $\check{S}^B$ and $\check{S}^C$ is S^A. Equation (16) is the surviving current face priced at $P^{index}(t)$ plus the present value of cash flows the index is waiting to receive. Starting at $t_{B\text{-}sw}$ there are two paydown and two coupon terms in the formula for the value of the Returns Universe. The paydown and coupon to be paid in month C are needed to calculate $P^{index}(t_{B\text{-}sw})$.

Equation (16) also shows that after $t_{B\text{-}sw}$, and before $t_{B\text{-}f}$, the value of the Returns Universe containing $1 of initial current face changes by the change in the PSA price scaled by ($\check{S}^B \times \check{S}^C = (S^A)^2$). In other words (ignoring the present value function), for $t_{B\text{-}sw} \le t < t_{B\text{-}f}$,

[13] To be included in the MBS Index in a given month, an annual aggregate must have at least $1 billion in current face as of the previous month's final paydown factor date. This minimum amount is often referred to as the "liquidity requirement" for the Barclays Capital Family of Indices. The liquidity requirement for the Barclays US Aggregate Index and its components, such as the MBS Index, was raised from $250 million to $1 billion on April 1, 2014.

$$\Delta\text{Value of the \$1 Returns Universe holding} \approx \check{S}^{B} \times \Delta P^{index}(t) \approx S^{A} \times S^{A} \times \Delta P^{C-psa}(t) \tag{17}$$

Although the index has yet to receive any cash (not until $t_{B\text{-}cf}$) the index value incorporates the expected cash receipts in months B and C.

At $t_{B\text{-}cf}$ we receive the paydown and coupon, so $PV[100^{B\text{-}cf}(t_{B\text{-}cf})] = 100$ and $PV[Cpn^{B\text{-}cf}(t_{B\text{-}cf})] = Cpn$. The index rule is that cash flows received during the month are not reinvested. So, these cash components of the index value remain static for the remainder of the month. At $t_{B\text{-}cf}$ the value of \$1 current face acquired by the index at $t_{B\text{-}mb}$ is:

$$\begin{aligned} V(t_{B-cf}) &= \check{S}^{B} \times \left\{P^{index}(t_{B-cf})\right\} + (1-\check{S}^{B}) \times 100 + Cpn + \check{S}^{B} \times AI(t_{B-cf}) \\ &= \check{S}^{B} \times \{\check{S}^{C} \times PV[P^{C-psa}(t_{B-cf}) + AI^{C-psa}(t_{B-cf})] + (1-\check{S}^{C}) \times PV[100^{C-cf}(t_{B-cf})] \\ &\quad + PV[Cpn^{C-cf}(t_{B-cf})] - AI(t_{B-cf})\} + (1-\check{S}^{B}) \times 100 + Cpn + \check{S}^{B} \times AI(t_{B-cf}) \end{aligned}$$

At this point the index continues to set $\check{S}^{B}$ and $\check{S}^{C}$ equal to S^{A}.

At $t_{B\text{-}f}$ the value of S_{B} is known. The index value is now:

$$\begin{aligned} V(t_{B-f}) &= S^{B} \times \left\{P^{index}(t_{B-f})\right\} + (1-S^{B}) \times 100 + Cpn + S^{B} \times AI(t_{B-f}) \\ &= S^{B} \times \{\check{S}^{C} \times PV[P^{C-psa}(t_{B-f}) + AI^{C-psa}(t_{B-f})] \\ &\quad + (1-\check{S}^{C}) \times PV[100^{C-cf}(t_{B-f})] + PV[Cpn^{C-cf}(t_{B-f})] - AI(t_{B-f})\} \\ &\quad + (1-S^{B}) \times 100 + Cpn + S^{B} \times AI(t_{B-f}) \end{aligned}$$

The index sets $\check{S}^{C}$ equal to S^{B}. If the actual value of S^{B} is significantly different from S^{A}, there may be a jump in the market value on this day.

The value at $t_{B\text{-}me}$ of \$1 current face acquired by the index at $t_{B\text{-}mb}$ equals:

$$\begin{aligned} V(t_{B-me}) &= S^{B} \times \left\{P^{index}(t_{B-me})\right\} + (1-S^{B}) \times 100 + Cpn + S^{B} \times Cpn \\ &= S^{B} \times \{S^{B} \times PV[P^{C-psa}(t_{B-me}) + AI^{C-psa}(t_{B-me})] \\ &\quad + (1-S^{B}) \times PV[100^{C-cf}(t_{B-me})] + PV[Cpn^{C-cf}(t_{B-me})] - Cpn\} \\ &\quad + (1-S^{B}) \times 100 + Cpn + S^{B} \times Cpn \end{aligned}$$

The index market value equations are summarized below.

Index Market Value Equations

for $t = t_{B-mb}$

$$\begin{aligned} V(t) &= P^{index}(t) + Cpn \\ &= \{S^{A} \times PV[P^{B-psa}(t) + AI^{B-psa}(t)] + (1-S^{A}) \times PV[100^{B-cf}(t)] \\ &\quad + PV[Cpn^{B-cf}(t)] - Cpn\} + Cpn \end{aligned} \tag{18}$$

for $\mathbf{t_{B-1} \le t < t_{B-sw}}$

$$\begin{aligned} V(t) &= S^A \times \left\{P^{index}(t)\right\} + (1-S^A) \times PV[100^{B-cf}(t)] \\ &\quad + PV[Cpn^{B-cf}(t)] + S^A \times AI(t) \\ &= S^A \times \{PV[P^{B-psa}(t) + AI^{B-psa}(t)] - AI(t)\} \\ &\quad + (1-S^A) \times PV[100^{B-cf}(t)] + PV[Cpn^{B-cf}(t)] + S^A \times AI(t) \end{aligned} \tag{19}$$

for $\mathbf{t_{B-sw} \le t < t_{B-cf}}$

$$\begin{aligned} V(t) &= S^A \times \left\{P^{index}(t)\right\} + (1-S^A) \times PV[100^{B-cf}(t)] \\ &\quad + PV[Cpn^{B-cf}(t)] + S^A \times AI(t) \\ &= S^A \times \left\{S^A \times PV[P^{C-psa}(t) + AI^{C-psa}(t)] \right. \\ &\quad \left. + (1-S^A) \times PV[100^{C-cf}(t)] + PV[Cpn^{C-cf}(t)] - AI(t)\right\} \\ &\quad + (1-S^A) \times PV[100^{B-cf}(t)] + PV[Cpn^{B-cf}(t)] + S^A \times AI(t) \end{aligned} \tag{20}$$

for $\mathbf{t_{B-cf} \le t < t_{B-f}}$

$$\begin{aligned} V(t) &= S^A \times \left\{P^{index}(t)\right\} + (1-S^A) \times 100 + Cpn + S^A \times AI(t) \\ &= S^A \times \left\{S^A \times PV[P^{C-psa}(t) + AI^{C-psa}(t)] \right. \\ &\quad \left. + (1-S^A) \times PV[100^{C-cf}(t)] + PV[Cpn^{C-cf}(t)] - AI(t)\right\} \\ &\quad + (1-S^A) \times 100 + Cpn + S^A \times AI(t) \end{aligned} \tag{21}$$

for $\mathbf{t_{B-f} \le t < t_{B-me}}$

$$\begin{aligned} V(t) &= S^B \times \left\{S^B \times PV[P^{C-psa}(t) + AI^{C-psa}(t)] \right. \\ &\quad \left. + (1-S^B) \times PV[100^{C-cf}(t)] + PV[Cpn^{C-cf}(t)] - AI(t)\right\} \\ &\quad + (1-S^B) \times 100 + Cpn + S^B \times AI(t) \end{aligned} \tag{22}$$

for $\mathbf{t = t_{B-me}}$

$$\begin{aligned} V(t) &= S^B \times \left\{S^B \times PV[P^{C-psa}(t) + AI^{C-psa}(t)] \right. \\ &\quad \left. + (1-S^B) \times PV[100^{C-cf}(t)] + PV[Cpn^{C-cf}(t)] - Cpn\right\} \\ &\quad + (1-S^B) \times 100 + Cpn + S^B \times Cpn \end{aligned} \tag{23}$$

Index Durations

Equation (15) shows that before the switch date, the change in the value of the \$1 current face index holding is a fraction $\check{S}^B$ of the change in the PSA price. In other words (ignoring the PV function):

$$\Delta V(t) \approx \check{S}^B \times \Delta P^{B-psa}(t), \qquad t_{B-mb} \le t < t_{B-sw} \tag{24}$$

Although the Returns Universe has yet to receive any paydown (that will not happen until $t_{B\text{-}cf}$), the price sensitivity of the index holding already incorporates the expected paydown. Assuming the duration of the paydown and coupon are zero, the duration of a security in the Returns Universe is given by:

$$\mathrm{Dur}^{\mathrm{ret\_univ}}(t_{B-1}) = w_{\mathrm{surv\_curr-face}}(t_{B-1}) \times \mathrm{Dur}_{\mathrm{current-face}}(t_{B-1}) < \mathrm{Dur}_{\mathrm{current-face}}(t_{B-1}) \tag{25}$$

where

$w_{\mathrm{surv\_curr\text{-}face}}(t_{B\text{-}1}) = (\check{S}^B \times (P^{\mathrm{index}}(t_{B\text{-}1}) + AI(t_{B\text{-}1})) / V(t_{B\text{-}1}) < 1$, and
$\mathrm{Dur}_{\mathrm{current\text{-}face}}(t_{B\text{-}1})$ = duration of a \$1 current face *assuming settlement at* $t_{B\text{-}1}$.

The Barclays Index Group also maintains a corresponding Statistics Universe during the month. Unlike the Returns Universe which is a static set of bonds, the Statistics Universe is dynamic, changing during the month to reflect new issuance and principal reductions from paydowns. At the end of each month, the Statistics Universe becomes the Returns Universe for the following month. Throughout the month, portfolio managers keep an eye on the Statistics Universe to monitor what the Returns Universe is likely to be once the new month arrives and to prepare any rebalancing transactions. In contrast to the Returns Universe, where each unit of current face at the beginning of the month is now a "conglomerate" position of surviving current face with accompanying expected cash receipts (paydown and coupon), each unit of current face in the Statistics Universe is for current month settlement and has yet to experience any paydowns or coupon receipts. Consequently,

$$\mathrm{Dur}^{\mathrm{ret\_univ}}(t_{B-1}) < \mathrm{Dur}_{\mathrm{current-face}}(t_{B-1}) = \mathrm{Dur}^{\mathrm{stat\_univ}}(t_{B-1}) \tag{26}$$

The relationship in (26) holds for our simplified single (premium) security index. For the MBS Index which contains hundreds of annual aggregates, the relationship in (26) may not hold after the beginning of the month as the composition of the Statistics Universe changes.

Components of Returns

The index produces an MTD price return, paydown return, and coupon return. The MTD index total return at $t_{B\text{-}1}$, $TR^{\mathrm{index}}(t_{B\text{-}1})$, is defined as their sum:

$$TR^{\mathrm{index}}(t_{B-1}) \equiv PR^{\mathrm{index}}(t_{B-1}) + PDR^{\mathrm{index}}(t_{B-1}) + CR^{\mathrm{index}}(t_{B-1}),$$

where (ignoring present value effects for simplicity):

$$\begin{aligned}
\textbf{price return: } \mathbf{PR^{index}(t_{B\text{-}1})} &\equiv \check{S}^B \times [P^{\mathrm{index}}(t_{B\text{-}1}) - P^{\mathrm{index}}(t_{A\text{-}me})]/BV^{\mathrm{index}}\\
\textbf{paydown return: } \mathbf{PDR^{index}(t_{B\text{-}1})} &\equiv (1 - \check{S}^B) \times [100 - P^{\mathrm{index}}(t_{A\text{-}me})]/BV^{\mathrm{index}}\\
\textbf{coupon return: } \mathbf{CR^{index}(t_{B\text{-}1})} &\equiv \check{S}^B \times AI(t_{B\text{-}1})/BV^{\mathrm{index}}, \text{ and}\\
\mathbf{BV^{index}} &\equiv P^{\mathrm{index}}(t_{A\text{-}me}) + Cpn
\end{aligned}$$

As discussed, on t_{B-1}, $P^{index}(t)$ jumps up from $P^{index}(t_{A-me})$.[14] Assuming $P^{B-psa}(t)$ is constant, $P^{index}(t)$ then declines steadily over the month as MTD accrued interest increases (see equation (11)). This discrete move in the index price on the first of the month (assuming an unchanged PSA price) reflects the price impact of the paydown. The index recognizes the paydown on the first day of the month even if the cash flow is not received until later in the month. The index records a negative (positive) paydown return, for premiums (discounts), on the first day equal to $(1 - \check{S}^B) \times PV[100^{B-cf}(t_{A-me}) - P^{index}(t_{A-me})]/BV^{index}$. In fact, if $P^{B-psa}(t_{B-1}) = P^{B-psa}(t_{A-me})$, the index paydown return is offset by the price return to produce a zero total return. The MTD paydown return then remains roughly static (it changes as its present value changes) until t_{B-f} when there will usually be an adjustment as the final factors are used to measure prepayments.

The coupon return on t_{B-1} is zero because $AI(t_{B-1})$ is zero.[15] If an investor buys an MBS for settlement at the end of the previous month, he pays a full month of accrued, which is returned to him on the cash flow date later in the month. For the ensuing month, however, the investor earns a coupon (i.e., accrued interest) return only on the portion S of current face that survives into month B. The index recognizes that the investor accrues coupon interest on the surviving portion from the settlement date (beginning of the month) throughout month B. The MTD coupon return gradually increases over the course of the month. By the end of the month, the investor has earned the full coupon return on the total amount of surviving current face.

When Does the Index Recognize the Paydown Return?

Assuming $P^{B-psa}(t_{B-mb}) = P^{B-psa}(t_{B-1})$ and ignoring daily present value accretion, what is $TR^{index}(t_{B-1})$? We know that there is a positive price return due to the increase in $P^{index}(t_{B-1})$. We also know that the index recognizes the negative paydown return at t_{B-1}. In fact, as shown earlier (with the PSA price unchanged),

$$PDR(t_{B-1}) = -PR(t_{B-1}), \text{ implying } TR^{index}(t_{B-1}) = 0$$

For many investors this result is confusing. The PSA price is unchanged and the index reports a negative paydown return (for premiums), yet the total return is near zero. However, the index also recognizes an offsetting positive price return. Many portfolio managers recognize the paydown return on the first day of the month (or whenever the paydown factor is published), but they make no offsetting price return as they are using the PSA (not index) prices. Consequently, investors generally show a negative total return on the paydown recognition date while their benchmark is flat.[16]

[14] For discount MBS, $P^{index}(t_{B-1})$ jumps down from $P^{index}(t_{A-me})$.

[15] The full formula for $CR^{index}(t_{B-1})$, which takes present value effects into account, is $(S^B \times AI(t_{B-1}) + PV[Cpn^{B-cf}(t_{B-1})] - Cpn)/BVindex$ which is a small negative number because $AI(t_{B-1})$ equals zero and the present value of the coupon is less than the coupon itself.

[16] This is so in an environment in which the index is at a substantial premium. Managers experience the opposite ("favorable") result when the index is at a substantial discount.

This is mainly a timing issue. While the manager's MTD total return initially drops by the negative paydown, his MTD total return gradually increases throughout the month at the coupon rate so that by the end of the month he will have earned Cpn. At the switch date, however, the manager experiences a negative price return equal to the "drop," i.e., the difference between $P^{B\text{-}psa}(t_{A\text{-}sw})$ and $P^{A\text{-}psa}(t_{A\text{-}sw})$. If the drop is at fair market value, then it should equal the value of month B's coupon minus month B's paydown (ignoring present value effects). After this drop in MTD total return, the manager's return resumes its upward trend due to the coupon accrual. Overall, assuming an unchanged PSA price and a "fair value" roll, the manager's monthly total return is close to zero, although it experiences some significant variation over the course of the month.

For the index, assuming an unchanged PSA price (except for the drop), the monthly total return is close to zero, and the daily MTD total returns are also generally zero. The paydown return on the first day is offset by an opposing price return. The "drop" in the PSA price on the PSA settlement day is offset by incorporating the following month's coupon and paydown, so there is no net change in the index price. While the index does report a daily coupon accrual,[17] the index price declines daily as the MTD accrued interest is subtracted, so there is no daily contribution to index total return from the coupon accrual. Overall, the MTD index total return is constant at approximately zero throughout the month.

In Figure 29.10, the dashed line represents the full P^{psa}. Again, we assume P^{psa} is constant except for the "drop" at $t_{B\text{-}sw}$ when the price changes from $P^{B\text{-}psa(t)}$ to $P^{C\text{-}psa(t)}$. The net

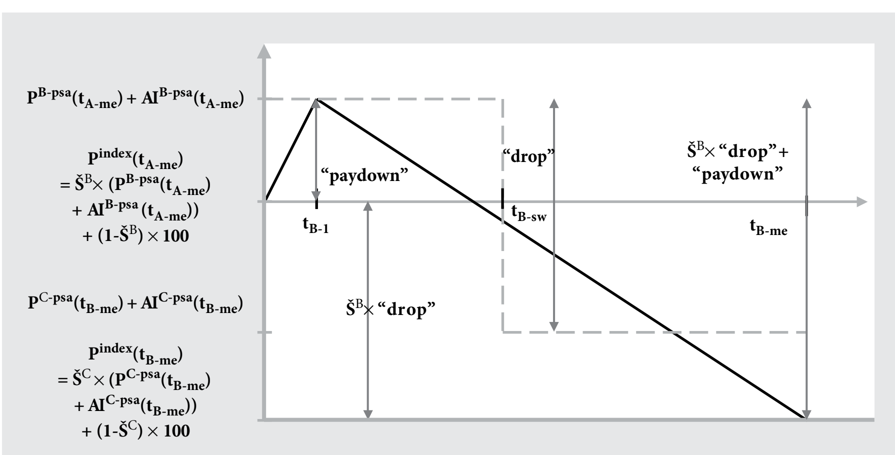

FIGURE 29.10 Index price dynamics in month B

Source: Barclays Research

[17] As per index convention, this accrual is in nominal terms, not present value terms, even though the coupon interest is not received until the following month. See footnote 15.

change in P^{psa} over the month equals the drop. This is what a portfolio manager sees. He would also measure his price return as equal to the surviving portion $S^B \times$ drop/BV. In contrast, the index price (the solid line) begins at $\check{S}^B \times [P^{B\text{-}psa}(t) + AI^{B\text{-}psa}(t)] + (1 - \check{S}^B) \times 100$ (with $\check{S}^B = S^A$), jumps up to $[P^{B\text{-}psa}(t) + AI^{B\text{-}psa}(t)]$ on the first day, and then steadily declines until it reaches its month-end value of $\check{S}^C \times [P^{C\text{-}psa}(t) + AI^{C\text{-}psa}(t)] + (1 - \check{S}^C) \times 100$ (with $\check{S}^C = S^B$). The net change in the index price is $S^B \times$ drop if S^A and S^B are equal. The total change in the two sets of prices is not the same. Although the index price jumps up at $t_{B\text{-}1}$, offsetting the negative paydown return, the index price declines throughout the rest of the month to offset the coupon accrual. Also note the difference between $P^{psa}(t_B)$ and $P^{index}(t_B)$ at $t_{B\text{-}sw}$: P^{psa} changes by the drop whereas P^{index} does not.

Comparing TR^{index} and TR^{PSA}

Figure 29.3 (given earlier) presents MTD TR^{index} by return component: Price Return, Paydown Return, and Coupon Return. MTD TR^{index} remains at zero throughout the month.[18]

TR^{psa} denotes MTD total returns calculated directly from PSA prices. While the full-month TR^{psa} is also zero, the intra-month pattern of TR^{psa} differs from TR^{index}. The paydown return (for a premium) is zero until the factor is published at $t_{B\text{-}pub}$.[19] In addition, the MTD price return is zero until the PSA switch date when the return is negative reflecting the drop. Finally, the coupon return is positive throughout the month. Overall, TR^{psa} is positive until $t_{B\text{-}pub}$ at which point it typically becomes negative. TR^{psa} then increases gradually to reflect the growing MTD coupon return. At the PSA switch date, the MTD price return (and total return) falls to reflect the drop. The total return then increases with the coupon return until the end of the month when MTD total return reaches zero. Figure 29.2 (presented earlier) shows the stylized dynamics for TR^{psa}.

While TR^{psa} and TR^{index} both show a zero monthly total return, they exhibit very different dynamics. Figure 29.5 (shown earlier) presents the difference in MTD total returns. Some portfolio managers see their relative underperformance at $t_{B\text{-}pub}$ and wonder if they will catch up to the index. This is particularly perplexing as they see that the index has already reported its negative paydown return at $t_{B\text{-}1}$. However, the manager accrues the daily coupon, and so his underperformance versus the index gradually diminishes over the course of the month.

[18] It should not be surprising that the total return equals zero, as the drop in price reflects the "no-arbitrage" condition of foregoing the coupon + paydown in order to delay settlement one month. The investor would expect to earn the short-term interest rate, which is zero in our example.

[19] The TR^{psa} calculation reduces current face when the preliminary factor is published. The current face amount is adjusted retroactively to the beginning of the month to correctly adjust accrued interest.

Will the Monthly TR^{psa} Equal TR^{index}?

Many MBS investors are willing to tolerate intra-month MTD TR^{psa} and TR^{index} differences. However, they want to know: "Will full month TR^{psa} equal TR^{index}?" Not necessarily. Suppose at $t_{A\text{-}me}$ the manager acquires $1 current face of the index security. The manager typically marks his book using PSA prices (usually without accrued interest as of the PSA settlement date) and shows a full month of accrued interest. At $t_{A\text{-}me}$ the base value equals $BV^{psa} = P^{B\text{-}psa}(t_{A\text{-}me}) + Cpn$. By $t_{B\text{-}me}$ the manager will have received:

- paydown gain or loss of $(1 - S^B) \times (100 - P^{B\text{-}psa}(t_{A\text{-}me}))$: We assume the manager holds the paydown when received and does not reinvest the cash flow; and
- full coupon, Cpn: Again, assuming the manager does not reinvest the coupon when received.

In addition, the remaining current face, S^B, is priced at the month-end PSA price, $P^{C\text{-}psa}(t_{B\text{-}me})$, plus a full month of accrued: $S^B \times (P^{C\text{-}psa}(t_{B\text{-}me}) + Cpn)$. At month-end, the total change in the portfolio value, by return component, is:

$$\begin{aligned} TR^{psa} &= \text{price return} + \text{paydown return} + \text{coupon return} \\ &= \{1/BV^{psa}\} \times \{S^B \times [P^{C-psa}(t_{B-me}) - P^{B-psa}(t_{A-me})] \\ &\quad +(1-S^B) \times [100 - P^{B-psa}(t_{A-me})] + S^B \times Cpn\} \end{aligned} \tag{27}$$

In contrast, TR^{index} components are:

$$\begin{aligned} &\textbf{Price return}(\mathbf{PR^{index}}) \equiv \left\{1/BV^{index}\right\} \times \check{S}^B \times \left\{P^{index}(t_{B-me}) - P^{index}(t_{A-me})\right\} \\ &= \left\{1/BV^{index}\right\} \times \check{S}^B \times \{\{\check{S}^C \times PV[P^{C-psa}(t_{B-me}) + Al^{C-psa}(t_{B-me})] \\ &\quad +(1-\check{S}^C) \times PV[100^{C-cf}(t_{B-me})] + PV[Cpn^{C-cf}(t_{B-me})] - Cpn\} \\ &\quad -\{S^A \times PV[P^{B-psa}(t_{A-me}) + Al^{B-psa}(t_{A-me})] + (1-S^A) \times PV[100^{B-cf}(t_{A-me})] \\ &\quad +PV[Cpn^{B-cf}(t_{A-me})] - Cpn\}\} \\ &= \{1/BV^{index}\} \times S^B \times \{\{S^B \times PV[P^{C-psa}(t_{B-me}) + Al^{C-psa}(t_{B-me})] \\ &\quad +(1-S^B) \times PV[100^{C-cf}(t_{B-me})] + PV[Cpn^{C-cf}(t_{B-me})] - Cpn\} \\ &\quad -\{S^A \times PV[P^{B-psa}(t_{A-me}) + Al^{B-psa}(t_{A-me})] + (1-S^A) \times PV[100^{B-cf}(t_{A-me})] \\ &\quad +PV[Cpn^{B-cf}(t_{A-me})] - Cpn\}\} \end{aligned}$$

Assuming that $PV[100^{C-cf}(t_{B-me})] = PV[100^{B-cf}(t_{A-me})] = PV[100^{cf}]$ and $PV[Cpn^{C-cf}(t_{B-me})] = PV[Cpn^{B-cf}(t_{A-me})]$, we have

$$\begin{aligned} \textbf{Price return}(\mathbf{PR^{index}}) = \left\{1/BV^{index}\right\} \times S^B \times \{S^B \times PV[P^{C-psa}(t_{B-me}) + AI^{C-psa}(t_{B-me})] \\ -S^A \times PV[P^{B-psa}(t_{A-me}) + AI^{B-psa}(t_{A-me})] + (S^A - S^B) \times PV[100^{cf}]\} \end{aligned}$$

Note that the price return involves both S^A and S^B, which are typically different. The index defines the beginning of the month base value as follows:

$$\begin{aligned}\mathbf{BV^{index}} &\equiv P^{index}(t_{A-me}) + Cpn \\ &= \check{S}^B \times PV[P^{B-psa}(t_{A-me}) + AI^{B-psa}(t_{A-me})] \\ &\quad + (1-\check{S}^B) \times PV[100^{B-cf}(t_{A-me})] + PV[Cpn^{B-cf}(t_{A-me})] \\ &= S^A \times PV[P^{B-psa}(t_{A-me}) + AI^{B-psa}(t_{A-me})] \\ &\quad + (1-S^A) \times PV[100^{B-cf}(t_{A-me})] + PV[Cpn^{B-cf}(t_{A-me})]\end{aligned}$$

S^B is unknown at $t_{A\text{-}me}$ so the index substitutes S^A. Note, however, when S^B becomes known, BV^{index} value does not change.

$$\begin{aligned}\textbf{Paydown return}(\mathbf{PDR^{index}}) &\equiv \{1/BV^{index}\} \times (1-\check{S}^B) \times \left\{100 - P^{index}(t_{A-me})\right\} \\ &= \{1/BV^{index}\} \times (1-\check{S}^B) \times \{100 - \check{S}^B \times PV[P^{B-psa}(t_{A-me}) + AI^{B-psa}(t_{A-me})] \\ &\quad -(1-\check{S}^B) \times PV[100^{B-cf}(t_{A-me})] - PV[Cpn^{B-cf}(t_{A-me})] + Cpn\} \\ &= \{1/BV^{index}\} \times (1-S^B) \times \{100 - S^B \times PV[P^{B-psa}(t_{A-me}) + AI^{B-psa}(t_{A-me})] \\ &\quad -(1-S^B) \times PV[100^{B-cf}(t_{A-me})] - PV[Cpn^{B-cf}(t_{A-me})] + Cpn\}\end{aligned}$$

$$\textbf{Coupon return}(\mathbf{CR^{index}}) \equiv \{1/BV^{index}\} \times S^B \times Cpn$$

Monthly index total return is defined as:

$$\mathbf{TR^{index}} \equiv \mathbf{PR^{index}} + \mathbf{PDR^{index}} + \mathbf{CR^{index}}$$

Assuming $PV[Cpn^{C\text{-}cf}(t_{B\text{-}me})] = PV[Cpn^{B\text{-}cf}(t_{A\text{-}me})] = PV[Cpn^{cf}]$, we get

$$\begin{aligned}TR^{index} = \{1/BV^{index}\} \times \{&(S^B)^2 \times \left\{ PV[P^{C-psa}(t_{B-me}) + AI^{C-psa}(t_{B-me})] \right. \\ &\left. - PV[P^{B-psa}(t_{A-me}) + AI^{B-psa}(t_{A-me})] \right\} \\ &+ S^B \times (1-S^B) \times \left\{100 - PV[P^{B-psa}(t_{A-me}) + AI^{B-psa}(t_{A-me})]\right\} + S^B \times Cpn \\ &+ (1-S^B)^2 \times \left\{100 - PV[100^{cf}]\right\} \\ &+ S^B \times (S^B - S^A) \times \left\{PV[P^{B-psa}(t_{A-me}) + AI^{B-psa}(t_{A-me})] - PV[100^{cf}]\right\} \\ &+ (1-S^B) \times \left\{Cpn - PV[Cpn^{cf}]\right\}\}\end{aligned} \tag{28}$$

$TR^{difference}$ equals the difference between equations (27) and (28):

$$TR^{difference} \equiv TR^{psa} - TR^{index}$$

At times $TR^{difference}$ can be significantly positive or negative. To see why, we simplify the TR^{index} expression by assuming $100 \approx PV[100^{cf}]$ and $Cpn \approx PV[Cpn^{cf}]$ which drops out two terms. The penultimate term, $S^B \times (S^B - S^A) \times \{PV[P^{B\text{-}psa}(t_{A\text{-}me}) + AI^{B\text{-}psa}(t_{A\text{-}me})] - PV[100^{cf}]\}$, can be significantly non-zero. This term can be referred to as the "prepayment estimation delta" term because the difference $(S^B - S^A)$ is the difference between S^A, which is used as the estimator of $\check{S}^B$ (before S^B is known), and the actual value of S^B. If prepayments are speeding up, then $(S^B - S^A) < 0$ and vice versa. How much the change in prepayment speeds affects $TR^{difference}$ depends on the potential loss due to prepayments, $\{PV[100^{cf}] - PV[^{B\text{-}psa}(t_{A\text{-}me}) + AI^{B\text{-}psa}(t_{A\text{-}me})]\}$. Consequently, we should expect $TR^{difference}$ to be influenced not only by the magnitude of $S^B \times (S^B - S^A)$ but also by the price level, $PV[P^{B\text{-}psa}(t_{A\text{-}me}) + AI^{B\text{-}psa}(t_{A\text{-}me})]$.

Ignoring the present value function and assuming $AI^{B\text{-}psa}(t_{A\text{-}me}) = AI^{C\text{-}psa}(t_{B\text{-}me})$, we have:

$$TR^{psa} \approx \left\{1/BV^{psa}\right\} \times \left\{S^B \times \Delta P^{psa} + (1 - S^B) \times [100 - P^{B-psa}(t_{A-me})] + S^B \times Cpn)\right\}$$

and:

$$\begin{aligned} TR^{index} \approx \{1/BV^{index}\} \times S^B \times \Big\{(S^B) \times \Delta P^{psa} + (1 - S^B) \times \{100 - P^{B-psa}(t_{A-me}) \\ - Al^{B-psa}(t_{A-me})\} + Cpn + (S^B - S^A) \times \{P^{B-psa}(t_{A-me}) + Al^{B-psa}(t_{A-me}) - 100\}\Big\} \end{aligned}$$

Assuming $BV^{psa} = BV^{index} = BV$ and ignoring the accrued interest terms in TR^{index}, we have:

$$\begin{aligned} TR^{difference} \approx \{1/BV\} \times \Big\{(1 - S^B) \times S^B \times \Delta P^{psa} + (1 - S^B)^2 \times \{100 - P^{B-psa}(t_{A-me})\} \\ - S^B \times (S^B - S^A) \times \{P^{B-psa}(t_{A-me}) - 100\}\Big\} \end{aligned} \qquad (29)$$

We offer several observations:

- If $S^B = S^A = 1$, then $TR^{difference} \approx 0$. There is a difference in that the index return includes the accrued interest to the PSA settlement date in the denominator whereas TR^{psa} includes a full month of coupon.
- If $S^B = S^A < 1$, then $TR^{difference}$ is increasing in ΔP^{psa}, holding $P^{B\text{-}psa}(t_{A\text{-}me})$ unchanged; and decreasing in $P^{B\text{-}psa}(t_{A\text{-}me})$, holding ΔP^{psa} unchanged. This result is greater the further S^B and S^A are from one.

To see this last point, Figure 29.11 shows how much current face is affected by ΔP^{psa} at different dates in month B. At $t_{B\text{-}1}$ the portfolio contains \$1 current face. TR^{psa} assumes it is priced at $P^{B\text{-}psa}(t_{A\text{-}me})$. In contrast, at $t_{B\text{-}1}$, the index recognizes that only S^A is priced at the present value of the PSA price, so its sensitivity to ΔP^{psa} is reduced by the S^A factor. By the end of the month, the sensitivity of the index returns to ΔP^{psa} is scaled down by $S^B \times S^B$ because this is the net amount of the \$1 in current face held at $t_{A\text{-}me}$ that will survive into month C. In contrast, TR^{psa} recognizes S^B dollars of current face starting at $t_{B\text{-}pub}$

	t_{B-1}	t_{B-pub}	t_{B-sw}	t_{B-f}	t_{B-me}
TR^{index}	S^A	S^A	$S^A \times S^A$	$S^B \times S^B$	$S^B \times S^B$
TR^{psa}	1	S^B	S^B	S^B	S^B

FIGURE 29.11 Influence on MTD returns from changes in PSA price (ignoring present value effect)

through the end of the month. The manager tends to outperform the index when PSA prices are rising and underperforms when they are falling.

As mentioned, $TR^{difference}$ is also a function of the paydown loss $\{100 - P^{B\text{-}psa}(t_{A\text{-}me})\}$. As a result, the higher the level of PSA prices the more TR^{psa} will tend to underperform TR^{index}.

- If $S^B > S^A$, then $TR^{difference}$ increases if ΔP^{psa} increases, holding $P^{B\text{-}psa}(t_{A\text{-}me})$ unchanged; and decreases if $P^{B\text{-}psa}(t_{A\text{-}me})$ increases, holding ΔP^{psa} unchanged.

This is a situation with decelerating prepayments between end of month A, when $S^A = \check{S}^B$ is used to calculate the initial market value, and end of month B, when $S^B = \check{S}^C$ is used to calculate the ending market value.

- If $S^B < S^A$, then $TR^{difference}$ is increasing in ΔP^{psa}, holding $P^{B\text{-}psa}(t_{A\text{-}me})$ unchanged; but can either increase, decrease, or remain constant as $P^{B\text{-}psa}(t_{A\text{-}me})$ increases, holding ΔP^{psa} unchanged, depending on the relationship between S^B and S^A.

It can be shown that for reasonable values of S^B, $(1 - S^B)^2 \times \{100 - P^{B\text{-}psa}(t_{A\text{-}me})\} - S^B \times (S^B - S^A) \times \{P^{B\text{-}psa}(t_{A\text{-}me}) - 100\}$ decreases as S^B increases for a premium passthrough, meaning that $TR^{difference}$ decreases as prepayments decelerate if $\Delta P^{psa} = 0$. The opposite result holds for discounts. In a refi wave from falling interest rates, P^{psa} will typically increase as prepayment speeds pick up. This will generally produce an increase in $TR^{difference}$. Later, as rates stabilize or rise, and prepayments decelerate, $TR^{difference}$ will tend to decrease.

Figure 29.12 presents some sample exact calculations of $TR^{difference}$ under various assumptions for S^A, $(S^B - S^A)$, $P^{B\text{-}psa}(t_{A\text{-}me})$, $P^{C\text{-}psa}(t_{B\text{-}me}) - P^{B\text{-}psa}(t_{A\text{-}me})$, and Cpn. To help develop intuition we examine some scenarios. We divide Figure 29.12 into two coupons: 3.5% and 4.5%. Given a coupon, pick a value of S^A. Three choices are given: 1, 0.98, and 0.96. (As a point of reference, a value of $S^A = 0.98$ for a passthrough with a WAC = 3.5 and WAM = 350 corresponds to a CPR of 20.0%.) For a given coupon and initial value of S^A, Figure 29.12 gives seven choices for $(S^B - S^A)$, ranging from −0.02 to +0.02. (Again, for point of reference, for the passthrough above, a value of $(S^B - S^A) = -0.02$ (i.e., $S^B = 0.96$) implies that the CPR accelerated to 37.5%.) Next, for a given coupon, initial value of S^A, and a value of $(S^B - S^A)$, Figure 29.12 gives five choices for $P^{B\text{-}psa}(t_{A\text{-}me})$, ranging in five-point increments from 95 to 115. Figure 29.12 also gives three choices for $P^{C\text{-}psa}(t_{B\text{-}me}) - P^{B\text{-}psa}(t_{A\text{-}me})$: −2, 0, and +2. Finally, Figure 29.12 assumes that the short-term

Coupon = 3.5%; r = 0.5%

Sa = 1

$\Delta P = -2$	Price 95	100	105	110	115
Sb–Sa −0.020	−13.8	−3.6	5.7	14.1	21.8
−0.010	−7.2	−1.9	2.8	7.1	11.1
−0.005	−3.8	−1.1	1.3	3.5	5.5
0.000	−0.3	−0.3	−0.2	−0.2	−0.2
0.005	–	–	–	–	–
0.010	–	–	–	–	–
0.020	–	–	–	–	–

$\Delta P = 0$	Price 95	100	105	110	115
Sb–Sa −0.020	−9.4	0.6	9.7	17.9	25.4
−0.010	−4.8	0.3	4.9	9.1	13.0
−0.005	−2.4	0.2	2.5	4.6	6.6
0.000	0.0	0.0	0.0	0.0	0.0
0.005	–	–	–	–	–
0.010	–	–	–	–	–
0.020	–	–	–	–	–

$\Delta P = +2$	Price 95	100	105	110	115
Sb–Sa −0.020	−5.0	4.8	13.6	21.7	29.0
−0.010	−2.4	2.6	7.1	11.2	14.9
−0.005	−1.0	1.5	3.7	5.8	7.7
0.000	0.4	0.3	0.3	0.3	0.2
0.005	–	–	–	–	–
0.010	–	–	–	–	–
0.020	–	–	–	–	–

Sa = 0.98

$\Delta P = -2$	Price 95	100	105	110	115
Sb–Sa −0.020	−16.8	−7.1	1.7	9.8	17.2
−0.010	−10.6	−5.5	−0.9	3.3	7.1
−0.005	−7.3	−4.7	−2.3	−0.1	1.9
0.000	−4.1	−3.9	−3.8	−3.6	−3.5
0.005	−0.7	−3.1	−5.2	−7.2	−9.0
0.010	2.7	−2.3	−6.7	−10.8	−14.6
0.020	9.7	−0.6	−9.9	−18.4	−26.1

$\Delta P = 0$	Price 95	100	105	110	115
Sb–Sa −0.020	−8.3	0.8	9.1	16.7	23.6
−0.010	−4.0	0.5	4.7	8.4	11.9
−0.005	−1.7	0.4	2.4	4.2	5.9
0.000	0.6	0.3	0.0	−0.2	−0.3
0.005	2.9	0.1	−2.3	−4.6	−6.6
0.010	5.3	0.0	−4.8	−9.1	−13.1
0.020	10.2	−0.3	−9.8	−18.5	−26.4

$\Delta P = +2$	Price 95	100	105	110	115
Sb–Sa −0.020	0.3	8.7	16.5	23.6	30.1
−0.010	2.7	6.6	10.3	13.6	16.8
−0.005	3.9	5.5	7.1	8.5	9.9
0.000	5.2	4.5	3.8	3.3	2.9
0.005	6.5	3.4	0.5	−2.0	−4.3
0.010	7.9	2.3	−2.8	−7.4	−11.6
0.020	10.7	0.0	−9.7	−18.5	−26.6

Sa = 0.96

$\Delta P = -2$	Price 95	100	105	110	115
Sb–Sa −0.020	−19.2	−10.5	−2.5	4.9	11.8
−0.010	−13.3	−9.0	−4.9	−1.2	2.3
−0.005	−10.3	−8.2	−6.2	−4.3	−2.6
0.000	−7.2	−7.4	−7.5	−7.6	−7.6
0.005	−4.1	−6.6	−8.9	−10.9	−12.7
0.010	−0.9	−5.8	−10.3	−14.3	−18.0
0.020	5.7	−4.2	−13.2	−21.4	−28.9

$\Delta P = 0$	Price 95	100	105	110	115
Sb–Sa −0.020	−6.7	1.0	8.2	14.8	20.9
−0.010	−2.7	0.8	4.0	7.1	9.9
−0.005	−0.6	0.6	1.9	3.1	4.3
0.000	1.5	0.5	−0.3	−1.0	−1.6
0.005	3.7	0.4	−2.6	−5.2	−7.5
0.010	5.9	0.2	−4.9	−9.4	−13.6
0.020	10.5	0.0	−9.6	−18.3	−26.2

$\Delta P = +2$	Price 95	100	105	110	115
Sb–Sa −0.020	5.8	12.5	18.8	24.6	30.1
−0.010	7.9	10.5	12.9	15.3	17.6
−0.005	9.1	9.5	9.9	10.5	11.1
0.000	10.3	8.4	6.9	5.6	4.4
0.005	11.5	7.4	3.8	0.5	−2.3
0.010	12.7	6.3	0.6	−4.6	−9.2
0.020	15.4	4.1	−6.0	−15.1	−23.5

Coupon = 4.5%; r = 0.5%

Sa = 1

Sb–Sa	ΔP = –2 Price 95	100	105	110	115	ΔP = 0 Price 95	100	105	110	115	ΔP = +2 Price 95	100	105	110	115
–0.020	–13.7	–3.5	5.8	14.2	21.9	–9.2	0.8	9.8	18.0	25.5	–4.7	5.0	13.9	21.9	29.2
–0.010	–7.1	–1.9	2.8	7.1	11.1	–4.7	0.4	5.0	9.2	13.1	–2.2	2.8	7.2	11.3	15.1
–0.005	–3.8	–1.1	1.3	3.5	5.5	–2.3	0.2	2.6	4.7	6.6	–0.9	1.6	3.8	5.9	7.8
0.000	–0.3	–0.3	–0.3	–0.3	–0.2	0.1	0.1	0.1	0.1	0.0	0.5	0.4	0.4	0.4	0.3
0.005	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
0.010	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
0.020	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Sa = 0.98

Sb–Sa	ΔP = –2 Price 95	100	105	110	115	ΔP = 0 Price 95	100	105	110	115	ΔP = +2 Price 95	100	105	110	115
–0.020	–16.6	–6.9	1.9	9.9	17.3	–8.0	1.1	9.3	16.9	23.8	0.7	9.1	16.7	23.8	30.3
–0.010	–10.4	–5.4	–0.8	3.3	7.2	–3.7	0.7	4.8	8.6	12.0	2.9	6.9	10.5	13.8	16.9
–0.005	–7.3	–4.6	–2.3	–0.1	1.9	–1.6	0.6	2.5	4.3	6.0	4.1	5.8	7.3	8.7	10.0
0.000	–4.0	–3.9	–3.7	–3.6	–3.5	0.7	0.4	0.1	–0.1	–0.3	5.4	4.6	4.0	3.4	3.0
0.005	–0.7	–3.1	–5.2	–7.2	–9.0	3.0	0.2	–2.3	–4.5	–6.6	6.7	3.5	0.7	–1.9	–4.2
0.010	2.6	–2.3	–6.8	–10.9	–14.6	5.3	0.0	–4.8	–9.1	–13.1	8.0	2.4	–2.7	–7.3	–11.5
0.020	9.5	–0.7	–10.0	–18.5	–26.2	10.1	–0.3	–9.8	–18.5	–26.4	10.8	0.0	–9.7	–18.5	–26.6

Sa = 0.96

Sb–Sa	ΔP = –2 Price 95	100	105	110	115	ΔP = 0 Price 95	100	105	110	115	ΔP = +2 Price 95	100	105	110	115
–0.020	–18.9	–10.2	–2.2	5.1	11.9	–6.3	1.4	8.4	15.0	21.1	6.3	12.9	19.1	24.9	30.4
–0.010	–13.1	–8.8	–4.7	–1.0	2.4	–2.4	1.0	4.2	7.3	10.1	8.3	10.8	13.2	15.5	17.8
–0.005	–10.1	–8.0	–6.1	–4.2	–2.5	–0.4	0.9	2.1	3.2	4.4	9.4	9.7	10.2	10.7	11.3
0.000	–7.1	–7.3	–7.4	–7.5	–7.5	1.7	0.7	–0.2	–0.9	–1.5	10.5	8.7	7.1	5.7	4.6
0.005	–4.0	–6.5	–8.8	–10.9	–12.7	3.9	0.5	–2.4	–5.1	–7.4	11.7	7.6	3.9	0.7	–2.2
0.010	–0.8	–5.8	–10.3	–14.3	–18.0	6.0	0.3	–4.8	–9.4	–13.6	12.9	6.5	0.7	–4.5	–9.1
0.020	5.6	–4.3	–13.3	–21.5	–29.0	10.6	0.0	–9.6	–18.3	–26.2	15.5	4.2	–5.9	–15.1	–23.4

FIGURE 29.12 $TR^{difference}$ calculations for various values of S^B, $(S^B - S^A)$, $P^{B\text{-}psa}(t_{A\text{-}me})$, $P^{C\text{-}psa}(t_{B\text{-}me}) - P^{B\text{-}psa}(t_{A\text{-}me})$, and Cpn, in bps

Note: Price = $P^{B\text{-}psa}(t_{A\text{-}me})$ and $\Delta P = P^{C\text{-}psa}(t_{B\text{-}me}) - P^{B\text{-}psa}(t_{A\text{-}me})$

Source: Barclays Research

investment rate is 0.5%. A comparison of the two halves of Figure 29.12 reveals that the coupon level does not have a significant impact on $TR^{difference}$, once the price level is taken into account.

Many of the S^A and $P^{B\text{-}psa}(t_{A\text{-}me})$ combinations presented in Figure 29.12 are not realistic. For example, if the price is 95, an S^A value of 0.96 is not likely. Nevertheless, for realistic combinations of the parameters, Figure 29.12 shows that $TR^{difference}$ can be significantly different from zero. Consider a 4.5% coupon passthrough with $P^{B\text{-}psa}(t_{A\text{-}me}) = 105$. If $S^A = 0.98$ and $S^B = 0.96$ and the PSA price does not change, then $TR^{difference} = 9.3$ bps. This result is roughly symmetric around $(S^B - S^A)$ so that if speeds slowed down and $S^B - S^A = +0.02$, then $TR^{difference} = -9.8$ bps. Note that the result is sensitive to $P^{C\text{-}psa}(t_{B\text{-}me}) - P^{B\text{-}psa}(t_{A\text{-}me})$. In this scenario, if prices rise by 2 (a bit extreme), then $TR^{difference}$ increases to 16.7 bps. Generally, in an accelerating prepayment environment ($S^B - S^A < 0$) with flat to increasing prices, par and premium annual aggregates have $TR^{difference} > 0$. Conversely, in a decelerating prepayment environment, with flat to decreasing prices, discount annual aggregates tend to have $TR^{difference} > 0$. Finally, par securities generally have a small $TR^{difference}$, irrespective of movements in prepayments as long as prices are flat.

Is a Non-Zero $TR^{difference}$ Transitory or Persistent?

Do values of $TR^{difference}$ persist, or do they tend to cancel out over short periods? Figure 29.6 (presented earlier) shows monthly values of $TR^{difference}$ for the MBS index[20] from February 2010 through March 2015. Monthly $TR^{difference}$ values are between ± 7 bps. The sum of all monthly $TR^{difference}$ values for the period was 33 bps, or 0.5 bps per month, or 6.3 bps per year. So, positive or negative $TR^{difference}$ values can persist, and cumulative $TR^{difference}$ can be significant. Figure 29.7 shows 12-month cumulative $TR^{difference}$.

Is one return calculation method more appropriate than the other? If the investor bought a security for settlement at the beginning of the month and sold it for settlement at the end of the month, what would be the investor's return? The TR^{psa} approach does not match up settlement prices with the evaluation dates, but the TR^{index} approach does. Consequently, index pricing methodology is particularly relevant to mutual funds which have intra-month inflows and outflows. Every day, the fund must calculate a net asset value so that investors buy and sell at the appropriate economic value as of that day.

[20] Returns for individual generics were aggregated by market value weight to produce the returns for the MBS Index. The beginning market values used as weights for TR^{index} were calculated according to the index method. The beginning market values used as weights for TR^{psa} were calculated according to the index method, not according to the manager method. One might argue that this is logically inconsistent, but we prefer to use one set of weights for both index-level return calculations so that the resulting value of $TR^{difference}$ would be the same as if we had calculated $TR^{difference}$ for each generic and then aggregated those differences using a consistent set of weights. In any case, it turns out that the results are almost identical either way.

Illustration: Comparing MTD TR^{index} and TR^{psa}

To illustrate TR^{index} and TR^{psa} differences we create a *portfolio* containing the FHLMC 30-year, 7.5% coupon pool #G00993. As of May 2003, this pool had a gross WAC of 7.856%, WALA of 69 months, factor of 0.16, and a 30 April 2003 PSA price of 106.7007. This pool was selected because its high dollar price and fast prepayments help highlight $TR^{difference}$. During the period under investigation, Barclays Research mapped this pool to the FGB07497 index annual aggregate.[21]

We create a *custom index*, "FGB07497_index," containing only a single index annual aggregate: FGB07497. Prices and returns for this index follow standard MBS index methodology. As per index methodology, the custom index assumes that any intra-month cash earns a zero reinvestment return. We assume the same when calculating TR^{psa}.

Here are the details for the pool:

Security: 31283HC6 (CUSIP), or FGG00993 (30-year 7.5% FHLMC passthrough)
Holding Period: (begin) 30 April 2003—(end) 31 May 2003
Data: CF(4/30/03) = $1,000,000 current face
CF(5/31/03) = $929,510 current face
$PD_{5/15est}$ = $71,191.00 (estimated paydown to be received on 5/15—based on the prior month's paydown factor for the annual aggregate)
$PD_{5/15act}$ = $70,490.00 (actual paydown to be received on 5/15)
$INT_{5/15}$ = $6,250.00 (interest to be received on 5/15)
$INT_{6/15}$ = $5,809.44 (interest to be received on 6/15)
P^{psa}(4/30/03) = 106.7007 (May PSA-settlement—5/14/03)
P^{index}(4/30/03) = 106.42 (same-day settlement—4/30/03)
P^{psa}(5/16/03) = 106.722 (June PSA-settlement—6/12/03)[22]
P^{psa}(5/31/03) = 106.5654 (June PSA-settlement—6/12/03)
P^{index}(5/31/03) = 106.209 (same-day settlement—5/31/03)

The portfolio is holder of record as of 4/30/03 and is entitled to receive the monthly cash flows (full coupon interest and paydown) on 5/15/03. For May returns calculations, the intra-month receipt of the coupon interest will not affect May's returns, as we are assuming a zero reinvestment rate. The paydown is another matter. There are two questions:

1. The May paydown amount is determined by the factor published in May. The holder of record as of 30 April is entitled to this paydown, so theoretically the paydown belongs in April's return. However, the paydown is not known until

[21] Index mapping of pools to annual aggregates is not static. As a pool's WALA changes, it may be mapped to different annual aggregates. Details for the index annual aggregate FGB07497 are as follows as of April 2003: WAC = 8.01% and WAM = 275.

[22] We present data for May 16, 2003 because we will show an intra-month performance calculation.

May. So which month's returns should reflect April's paydown (received in May), April (which would have to be restated) or May? We assume the paydown received in May affects May's returns, which is what most investors and the index do.[23]

2. When in the month should the paydown return occur? On the first day of the month (using estimated factors); on the day the initial factor is published; or on the cash flow receipt date? TR^{psa} recognizes the paydown when it is published. However, like most investors, once the factor is published, the current face holding and accrued interest is restated as of the first of the month. Consequently, the MTD impact of the paydown appears as of the first day of the month even though the factor was published later.[24]

The monthly TR^{psa} is:

$$TR^{psa} = (TV^{psa}(E) / TV^{psa}(B)) - 1$$

where $TV^{psa}(E)$ and $TV^{psa}(B)$ equal the total market value of the position at time E(nd) and B(egin), respectively.

$$\begin{aligned} TV^{psa}(B) &= CF(B) \times [P^{psa}(B) + Cpn] \\ &= \$1,000,000 \times [106.7007\% + 0.625\%] = \$1,073,257.00 \end{aligned}$$

Note: On the last calendar day of the month, TR^{psa} uses $[P^{psa}(B) + Cpn]$, not $[P^{psa}(B) + AI(B)]$, to calculate $TV(\cdot)$. The Bloomberg "HTR" function uses $[P^{psa}(B) + AI(B)]$. Some other managers may use $[P^{psa}(B) + AI^{psa}(B)]$.

$$\begin{aligned} TV^{psa}(E) &= CF(E) \times [P^{psa}(E) + Cpn] + PD_{5/15act} + INT_{5/15} \\ &= \$929,510 \times [106.5654\% + 0.6250\%] + \$70,490 + \$6,250 = \$1,073,085.49 \end{aligned}$$

For May 2003 TR^{psa} equals:

$$TR^{psa} = (\$1,073,085.49 / \$1,073,257) - 1 = -0.02\%$$

MTD TR^{psa} through 16 May 2003 is:

$$TR^{psa} = (\$1,071,636.38 / \$1,073,257.00) - 1 = -0.15\%$$

We compare MTD total returns for the pool portfolio (TR^{psa}) and the custom index FBG07497 (TR^{index}). Figure 29.13 presents daily PSA and index prices, duration, OAS,

[23] Same-day settle for the index means that the May factor affects May's returns to the extent that the estimated factor value differs from the actual factor.

[24] If the factor is not yet available, the Bloomberg HTR screen flashes in red "End date has unavailable factors." Bloomberg does not use estimated factors. However, once the factor becomes available, Bloomberg begins to report holding period returns as if the factor was known on the first day of the month.

and paydown information as well as UST 2-year yields.[25] The key index pricing and portfolio cash flow events, t_{sw}, t_{cf}, and t_f, are labeled.

Figure 29.13 shows that the PSA price for the FHLMC 7.5% 1997 fell modestly during the month. As a first step, we do an approximate total return calculation for the FGB07497 index. The SMM (published in May) for the annual aggregate FGB07497 was 0.077945. Given a price level of approximately 106.70, this would produce a paydown loss (ignoring scheduled principal payments) of approximately 49 bps for the month [0.0049 = (100–106.70) × 0.077945 ÷ 106.70]. The coupon rate of 7.5% produces a coupon gain of approximately 54 bps for the month [0.0054 = (1–0.077945) × (7.5/12) ÷ (106.70)]. The unscheduled paydown and coupon returns should produce a combined return of approximately 5 bps. To calculate total return more closely, we must add the price return component. We see from Figure 29.13 that over the course of the month the

	PSA Settle Date FGB07497	PSA Price FGB07497	Index Price FGB07497	OAD FGB07497	OAS FGB07497	SMM FGB07497	UST 2–Year Yield 1 5/8 of 4/30/05
4/30/2003	5/14/2003	106.7007	106.420	−0.37	31.8	0.070005	1.49%
5/1/2003	"	106.6985	106.919	−0.35	40.9	"	1.47%
5/2/2003	"	106.6988	106.902	−0.31	41.0	"	1.57%
5/5/2003	"	106.7008	106.853	−0.34	42.0	"	1.53%
5/6/2003	"	106.7007	106.836	−0.40	41.0	"	1.43%
5/7/03 (t_{f-pub})	"	106.6975	106.816	−0.52	31.6	"	1.41%
5/8/2003	"	106.6932	106.795	−0.57	27.9	"	1.46%
5/9/2003	"	106.7232	106.808	−0.59	30.3	"	1.44%
5/12/03 (t_{sw})	6/12/2003	106.6619	106.675	−0.59	34.7	"	1.44%
5/13/2003	"	106.6656	106.661	−0.61	31.9	"	1.44%
5/14/03 (t_{psa})	"	106.7143	106.689	−0.67	21.6	"	1.39%
5/15/03 ($t_{cf-pool}$)	"	106.7050	106.663	−0.65	21.2	"	1.43%
5/16/2003	"	106.7220	106.662	−0.66	20.0	"	1.31%
5/19/2003	"	106.7168	106.607	−0.64	18.1	"	1.35%
5/20/2003	"	106.7143	106.587	−0.64	8.6	"	1.26%
5/21/2003	"	106.7023	106.559	−0.62	5.6	"	1.36%
5/22/03 (t_f)	"	106.7023	106.487	−0.64	12.7	0.077945	1.33%
5/23/2003	"	106.7023	106.470	−0.65	12.0	"	1.35%
5/27/03($t_{cf-index}$)	"	106.7013	106.402	−0.6	11.8	"	1.31%
5/28/2003	"	106.5771	106.271	−0.54	17.5	"	1.31%
5/29/2003	"	106.5737	106.250	−0.56	12.7	"	1.27%
5/30/2003	"	106.5654	106.209	−0.56	8.6	"	1.30%
5/31/03(Saturday)	"	106.5654	106.209	−0.56	8.6	"	1.30%

FIGURE 29.13 Daily information for index annual aggregate FGB07497, May 2003

Source: Barclays Research

[25] The SMM for pool FGG00993 was 2.45% and 6.93%, published in April and May, respectively. The 1-month CPRs were 25.8% and 57.8%, respectively. The 1-month CPRs for the annual aggregate were 58.14% and 62.24%, respectively.

PSA price fell from 106.7007 (May PSA) to 106.5654 (June PSA). This price drop produces a −13 bp price return. Combining the return components, the total return is approximately −8 bps. Given the high dollar price, when we include scheduled principal payments, the total return should be somewhat lower.

Figure 29.14 presents May's MTD TR^{psa} and TR^{index}. TR^{psa} shows the impact of April's rapid prepayments immediately in the month.[26] In contrast, the index had already recognized the monthly coupon gain and April's (estimated) paydown loss simultaneously, along

	TR^{psa} FGG00993	TR^{index} FGB07497
30–Apr–03	0.00	0.00
01–May–03	−0.44	0.00
02–May–03	−0.42	0.01
05–May–03	−0.37	0.02
06–May–03	−0.35	0.02
07–May–03(t_{f-pub})	−0.33	0.02
08–May–03	−0.32	0.02
09–May–03	−0.28	0.05
12–May–03 (t_{sw})	−0.28	−0.01
13–May–03	−0.25	0.00
14–May–03 (t_{psa})	−0.19	0.04
15–May–03 ($t_{cf-pool}$)	−0.18	0.04
16–May–03	−0.15	0.05
19–May–03	−0.10	0.06
20–May–03	−0.09	0.06
21–May–03	−0.08	0.06
5/22/03 (tf)	−0.06	−0.04
23–May–03	−0.04	−0.04
27–May–03 ($t_{cf-index}$)	0.03	−0.02
28–May–03	−0.06	−0.12
29–May–03	−0.04	−0.12
30–May–03	−0.03	−0.12
31–May–03 (Saturday)	−0.02	−0.12

FIGURE 29.14 MTD total returns (in percent), TR^{psa} and TR^{index}, May 2003

Source: Barclays Research

[26] Once factors are published, most managers restate their current face holdings as of the beginning of the month. In this example we follow the similar convention. Consequently, the impact of the paydown will appear as of the first day of the month even though the factor was reported later.

	PSA Price FGB07497	Index MTD Total Return = FGB07497	Index MTD Price Return FGB07497	Index MTD Coupon Return FGB07497	Index MTD Paydown Return FGB07497
4/30/2003	106.7007				
5/1/2003	106.6985	0.0022	0.4327	−0.0003	−0.4302
5/2/2003	106.6988	0.0062	0.4183	0.0178	−0.4299
5/5/2003	106.7008	0.0189	0.376	0.0721	−0.4292
5/6/2003	106.7007	0.0225	0.3612	0.0902	−0.429
5/7/03 ($t_{f\text{-}pub}$)	106.6975	0.0234	0.3438	0.1083	−0.4287
5/8/2003	106.6932	0.0233	0.3253	0.1264	−0.4285
5/9/2003	106.7232	0.0529	0.3366	0.1445	−0.4282
5/12/03 (t_{sw})	106.6619	−0.0076	0.2211	0.1988	−0.4275
5/13/2003	106.6656	−0.001	0.2094	0.2169	−0.4273
5/14/03 (t_{psa})	106.7143	0.0418	0.2338	0.235	−0.427
5/15/03 ($t_{cf\text{-}pool}$)	106.705	0.0372	0.2112	0.2531	−0.427
5/16/2003	106.722	0.0542	0.2101	0.2711	−0.427
5/19/2003	106.7168	0.0603	0.1619	0.3254	−0.427
5/20/2003	106.7143	0.0616	0.1452	0.3435	−0.427
5/21/2003	106.7023	0.0555	0.121	0.3614	−0.427
5/22/03 (tf)	106.7023	−0.0404	0.0578	0.3764	−0.4746
5/23/2003	106.7023	−0.0369	0.0434	0.3943	−0.4746
5/27/03 ($t_{cf\text{-}index}$)	106.7013	−0.0243	−0.0157	0.466	−0.4746
5/28/2003	106.5771	−0.1193	−0.1286	0.4839	−0.4746
5/29/2003	106.5737	−0.1186	−0.1459	0.5018	−0.4746
5/30/2003	106.5654	−0.1184	−0.1815	0.5377	−0.4746
5/31/03 (Saturday)	106.5654	−0.1184	−0.1815	0.5377	−0.4746

FIGURE 29.15 Components of MTD index total returns (in percent), index annual aggregate: FGB07497, May 2003

Source: Barclays Research

with the PSA price drop, on the previous month's switch date. Over the course of the current month, the total return for the index fluctuates as the PSA price changes and as future cash flows accrete value based on the short-term interest rate. Since the PSA price for this generic was relatively unchanged during the month, we should expect small movements in the MTD TR^{index}. For TR^{psa}, however, we should expect substantial fluctuations as the paydown and coupon component of returns are recognized at different times.

Figure 29.15 shows the MTD TR^{psa} and TR^{index}: price, coupon, and paydown returns.

Figure 29.13 provides a good illustration of P^{psa} and P^{index} moving in opposite directions. From April 30 to May 1, P^{psa} dropped 0.0022 but P^{index} increased 0.499 to produce an index price return of +43 bps. This price return offsets the negative paydown return (−43 bps).[27]

[27] As discussed, there is a negligible negative index coupon return on the first day of the month. Note the −0.0003 coupon return for May 1 in Figure 29.15.

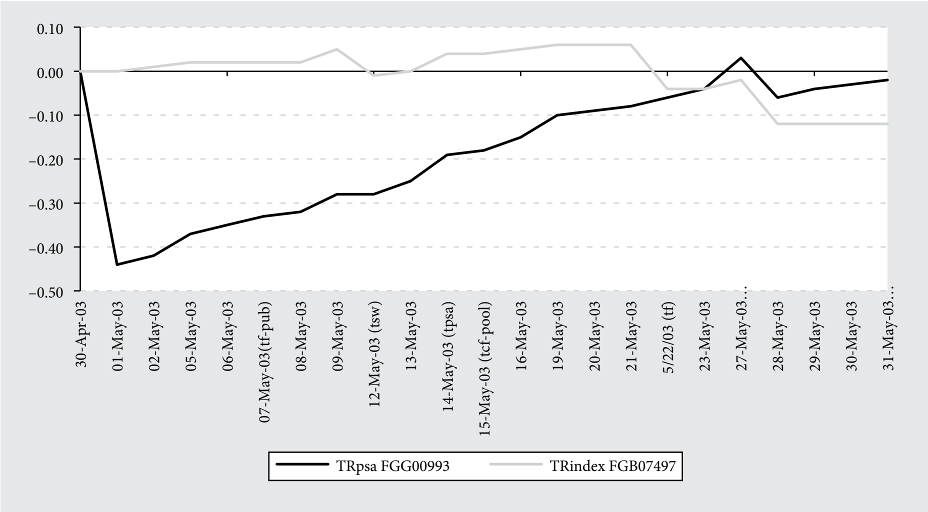

FIGURE 29.16 MTD total returns, TR^{psa} versus TR^{index}, FGG00993 (TR^{psa}), and FGB07497 (TR^{index}), May 2003, in %

Source: Barclays Research

Figure 29.16 presents a graph of MTD TR^{psa} and TR^{index}. As discussed, TR^{psa} recognizes the large negative paydown return on the first business day, producing an MTD total return of −44 bps. The index publishes a large negative MTD paydown return on May 1 (−43 bps) which is offset by the price return to produce a total return of 0 bps. At this point the index is using an estimated paydown factor (equal to the prior month's paydown factor) for TR^{index} whereas TR^{psa} is using the actual factor published in May.

Moving through the month, both TR^{index} and TR^{psa} react to changes in P^{psa}. In addition, TR^{psa} recognizes a daily coupon accrual. Since the P^{psa} changes little over the month (except May 28, 2003), the MTD TR^{psa} series increases smoothly with the coupon. In contrast, TR^{index} increases with LIBOR which in May 2003 was approximately 1.3%.

On 12 May (t_{sw}) PSA settlement switches from May to June. The percentage decline in the PSA price (a combination of the drop and market change over the day) was 5.7 bps, or approximately 2/32nds in price terms. The 12th also happened to be a Monday which meant that the returns reflected three days of accrued coupon (about 6 bps total). Coincidentally, the negative index price return offset the coupon return so that MTD TR^{psa} was unchanged. MTD TR^{index} fell from +5 bps to −1 bps. As discussed, while the index reports a daily coupon accrual, the price return offsets this. On the 12th, when the index switches PSA settlement months, the TR^{index} reflects only the percentage change in the PSA price, approximately −6 bps.

On May 15, the holder of record in the prior month receives the coupon and principal cash flows. However, as this coupon payment was not "earned" in the current month, it does not contribute to May's returns. The receipt of the coupon would only impact May's returns if interest were subsequently earned on the coupon. The index assumes cash flow received is not reinvested. For TR^{psa} we also assume a 0% reinvestment rate to properly compare TR^{psa} and TR^{index}. However, in practice, portfolio managers can add to performance by reinvesting cash for the remainder of the month.

On the 22nd, the index updates the paydown factors for all annual aggregates. The SMM for the annual aggregate increased from 0.070005 to 0.077945 (corresponding to a change in CPR from 58.14% to 62.24%), causing the S value to change from 0.928799 to 0.920869. TR^{psa} is unaffected on this date as it has been using the prepayment factor published in May all along. In contrast, the index must recognize that the estimated paydown factor it had been using so far this month was too low. As described earlier, there are two impacts: a negative price return and a larger negative paydown return. Together they produce a drop in the MTD total return. The negative impact on the price return is due to the reduction in the index price as a result of the new, lower value for S. The index price falls by approximately $\Delta S \times (P^{psa} + AI^{psa} - 100) = (0.00793) \times 6.9315$, which produces 5 bps of negative return. The impact on the paydown return is $\Delta S \times (P^{index} - 100) = (0.00793) \times 6.42$ which produces another 5 bps of negative return. This negative return reflects the fact that the index assumed (in the previous month) that too much current face would survive to this month. Consequently, the paydown return must be adjusted downward. Together, these two adjustments produce a 10 bp drop in the MTD TR^{index} on May 22. Note that TR^{psa} increases about 2 bps on the day as there was no change in the PSA price and the daily coupon accrual is about 2 bps per day.

On the 28th, TR^{index} and TR^{psa} both show a large drop. This drop is due entirely to market movements on that day, as reflected in P^{psa}, and is not connected with the details of either return calculation methodology.

At month-end TR^{psa} is −1.6 bps. There was little price movement during the month. After the initial 44 bps drop on the first day due to the paydown, TR^{psa} gradually increased throughout the month at approximately 2 bps per day.

We should expect a difference in returns between FGB07497 and FGG00993 due to differences in prepayments. As mentioned above, the May 2003 S value for FGB07497 was 0.920869. For FGG00993 it was 0.929510 for a difference of 0.008641. This difference in prepayments should produce a difference in total returns of approximately $(0.008554) \times 6.7 \div 106.7 = 5.4$ bps.

TR^{index} for FGB07497 is −11.8 bps, significantly different from the −1.6 bps for TR^{psa}. We know that 5.4 bps of the difference between TR^{psa} and the TR^{index} is due to the different prepayment speeds. This leaves about 4.8 bps left to explain. From our model we predict a $TR^{difference}$ value of 4.9 bps (i.e., outperformance of TR^{psa} versus TR^{index}) for this annual aggregate, given the level of prices and prepayments.

Depending on the portfolio performance system the manager is using, there can be a wide variation in MTD TR^{psa} and TR^{index}. As an example, consider May 7 (Figure 29.14). On this day, TR^{psa} shows −33 bps whereas TR^{index} reports +2 bps. Imagine a portfolio manager using TR^{psa}. On May 7 it appears that he is underperforming the index by 35 bps. The manager's initial reaction is that TR^{psa} has already reflected the paydown but the index has not. However, when the manager looks at the components of index returns he will see that the index is already reporting an MTD paydown return of −43 bps (see Figure 29.15).

The manager will notice the large price return, but will see that the MTD PSA price change is negative (106.6975–106.7007). This has been a source of confusion.

Note the more subdued behavior of MTD TR^{index} returns. The index methodology recognizes that the index holding of current face will receive coupon return and have a negative paydown return, plus any price return. However, why is there no sharp negative total return due to the large paydown that appears in TR^{psa}? Why is there no gradual increase in total return due to the accrual of coupon as shown by TR^{psa}? The answer lies in the same-day settlement convention of the index.

Key Points

- Some managers use the nearest PSA-settlement price, P^{psa}, to value some or all of their MBS holdings, whereas the index calculates its own price, P^{index}.
- The fundamental difference between P^{psa} and P^{index} lies in their respective settlement dates. As a result, P^{psa} and P^{index} are rarely equal, can change by different amounts, and even move in opposite directions.
- The difference between P^{psa} and P^{index} arises because P^{index} reflects the coupon and paydown to be received next month by an investor who acquires the security this month, whereas P^{psa} does not. Differences in pricing lead to differences in how the MBS index and a portfolio manager value their holdings. This difference, in turn, can lead to differences in duration and in monthly return performance numbers. Furthermore, these monthly differences may not always "even out" across months.
- The MTD TR^{index} tends to be smoother than those calculated using PSA settlement prices. On the day paydown factors are published, returns using PSA settlement prices recognize the paydown and record the resulting discrete change in total return. On the switch date there is another discontinuous movement in total return due to moving the P^{psa} settlement date to the following month. In contrast, there are generally no sharp movements in the MTD TR^{index} unless there are large changes in (estimated or actual) paydown factors and/or changes in P^{psa} due to market movements.
- Knowing how the index calculates prices and returns is an important step to either track or outperform this popular benchmark.

Acknowledgment

We wish to acknowledge the contribution of Dr Jordan I. Mann to this chapter.

CHAPTER 30

MBS INDEX REPLICATION WITH TBAs

NIKKI STEFANELLI AND BRUCE D. PHELPS

After reading this chapter you will understand:

- benchmark construction of the Barclays US Agency MBS Fixed-Rate Index, which tracks the market for Freddie Mac, Fannie Mae, and Ginnie Mae mortgage-backed passthrough pools.
- unlike other fixed-income benchmarks, the MBS Index uses non-traded "generics" or "annual aggregates" to represent all individual MBS pools for a given agency/program, coupon, and annual vintage.
- how the index same-day settlement pricing convention and total return methodology help in understanding any investment strategy, either active or passive.
- a strategy to replicate the total return of the MBS Index using a portfolio of "to-be-announced" contracts or TBAs, which are non-index eligible forward contracts on MBS pools.
- how TBA replication offers investors an opportunity to efficiently gain MBS beta exposure through a large, liquid market without the portfolio management and back office overhead of a full-fledged MBS portfolio operation.
- the historical tracking performance of the TBA proxy portfolio, which is maintained by Barclays and is called "REMIX."
- sources of performance differences between the TBA proxy portfolio and the MBS Index.
- how misalignments in sector and coupon distribution and pricing methodology differences between TBAs and index generics are among the drivers of tracking error.

US agency mortgage-backed securities (MBS), which "pass through" monthly payments of underlying "pools" of mortgages, represent a large and relatively homogeneous asset class. MBS are widely followed by global investors for their AAA-rating, good liquidity, and modest outperformance against key-rate duration-matched Treasuries. The Barclays

US MBS Index, a commonly used benchmark to track this market since its launch in 1986, is constructed by grouping individual mortgage pools into index "generics" based on a pool's agency/program, coupon, and vintage.

With roughly $5 trillion in market value, the MBS Index represents a significant portion of broad-based indices, including the US Aggregate[1] and multi-currency Global Aggregate (28.1% and 11.5%, respectively, as of May 2015). As such, both US and global managers seeking diversified market exposure will have significant allocations to MBS. Some asset managers aim to outperform the MBS Index component, but given the highly variable and technical nature of the cash flows, this generally requires the following: (1) substantial investment in talent and infrastructure, or (2) the hiring of an MBS subadvisor. In contrast, other firms simply look to obtain MBS beta exposure via index replication and use resources to specialize in other sectors to outperform their broad benchmark. We show how it is possible to closely replicate MBS Index returns in a relatively straightforward manner, requiring little MBS expertise and infrastructure.

The TBA replication strategy (called "REMIX") for the MBS Index was developed in 2001 and continues to be maintained by the Barclays research team. REMIX uses liquid "to-be-announced" or TBA contracts to track benchmark returns, rather than the specific MBS pools that are part of the index. In the specified pool market, portfolio managers know exactly which mortgage-backed passthroughs they are buying or selling and, consequently, their relevant characteristics, such as weighted-average maturity (WAM), weighted-average coupon (WAC), and average loan balance. In contrast, in the TBA market, counterparties enter into forward agreements to transact in unspecified MBS pools. On the TBA trade date, the buyer and seller agree only upon the agency/program and coupon (e.g., FNMA Conventional 30-year with a 4% coupon) attributes of the pools to be exchanged, not the exact pools. Not until Notice Day, shortly before the forward settlement date, does the seller reveal the specific pool(s) to be delivered. The idea behind the TBA market is that there is a sufficient supply of eligible pools that are reasonably close substitutes to each other in value, giving buyers and sellers reasonable expectation of the specifics of the pools likely to be delivered.

The Barclays US MBS Index

The Barclays US Agency Fixed-Rate MBS Index comprises index "generics" that are formed by aggregating approximately one million individual fixed-rate MBS pools guaranteed by Freddie Mac (FHLMC), Fannie Mae (FNMA), and Ginnie Mae

[1] In addition to agency fixed-rate MBS, the US Aggregate Index also includes agency hybrid adjustable-rate mortgage (ARM) securities (since April 2007). We discuss fixed-rate MBS replication only due to the small weight of hybrid ARMs in the US Aggregate Index (0.3% by market value as of May 2015) and the absence of a hybrid ARM TBA market. The Global Aggregate Index includes fixed-rate MBS only.

(GNMA) based on three characteristics: program (e.g., Fannie Mae Conventional 30-year), coupon (e.g., 4%), and origination year (based on weighted-average loan age or WALA).[2] The generics are assigned eight-character index identifiers along these three dimensions: the first three characters represent the program or sector; the next three represent the fixed-rate coupon in eighths; and the last two represent the origination year. For example, pool FN #AJ7689 is a FNMA 4% passthrough security containing 30-year mortgage loans originated in 2011, and is mapped to the 2011 FNMA 30-year 4% index generic (FNA04011). To be index-eligible, MBS generics must meet minimum index maturity (weighted-average maturity, or WAM, of at least one year) and minimum liquidity criteria ($1bn or more of current face outstanding).[3] As of May 2015, while there were roughly 3,800 annual MBS generics, only 311 met the MBS Index inclusion rules.

To manage against the MBS Index, investors generally trade either settled MBS pools (i.e., the securities which underlie index generics) or non-index eligible, to-be-announced contracts, which are forward contracts to buy or sell pools of a given agency/program and coupon. Unlike the holder of a TBA position, a holder of a settled pool is entitled to a pro-rata share of the pool's monthly interest and principal payments (scheduled and unscheduled). The magnitude of these monthly payments depends on the prepayment behavior of the underlying individual mortgage loans.[4]

Index Pricing and Returns

Knowing how the MBS Index computes returns is important for any replication strategy.[5] The MBS Index return is derived from each generic's total return and market value weight, which is reset at each month-end index rebalancing. Each generic's market value weight is based on its beginning-of-the-month price, accrued interest, and par amount outstanding. The three components of an MBS generic's total return are:

[2] When it was initially launched, the MBS Index measured the market for 30-year and 15-year GNMA, FHLMC, and FNMA MBS. The index has evolved to add and remove certain programs and security types (20-year were first included in July 2000; balloons were added in 1992 and removed in January 2008). MBS pools held in collateralized mortgage obligations (CMOs) or by the US Federal Reserve in the System Open Market Account (SOMA) remain eligible (as part of index generics) for the US Aggregate and Global Aggregate Indices.

[3] Prior to April 1, 2014, the minimum liquidity for index inclusion of MBS fixed-rate generics was $250 million.

[4] Investors may observe large prepayment differences among the pools that contribute to the same index generic, arising from such differences as average loan size, average loan-to-value (LTV) ratio, and geographical concentration. Smaller pools, containing fewer loans, are likely to be more prone to idiosyncratic prepayment behavior than larger pools.

[5] For additional details on MBS index pricing and returns, see Chapter 29.

1. *price return*, resulting from movements in price;
2. *coupon return*, derived from interest earned by pools; and
3. *paydown return*, related to both scheduled and unscheduled payments of principal passed through to holders of the pools underlying each generic.[6]

The market pricing convention for MBS is based on monthly forward settlement dates, which are set by the Securities Industry and Financial Markets Association (SIFMA).[7] Such forward prices are colloquially referred to as "forward-settle" or "PSA settle" prices, and are sometimes used by portfolio managers to calculate performance, often for TBA positions. However, changes in forward-settle prices can experience predictable intra-month jumps when the forward settlement month changes, even if the underlying mortgage market is unchanged. Consequently, forward-settle prices are not appropriate for pricing mortgage funds (or an index) that experience daily inflows and outflows.

The MBS Index uses a same-day (i.e., T+0) settlement assumption. The index same-day settle bid-side price is based on the PSA bid price, but is discounted back from the forward-settle date to today, after making appropriate adjustments for anticipated cash flows. If the forward settlement date is in the following month, the same-day settle price incorporates the discounting of (currently unknown) cash flows (principal paydown and interest) which would be received by the MBS pool's owner. For index same-day settle prices, paydowns are provisionally based on the prior month's survival rate until actual prepayment data are incorporated later in the month.

Over the course of a given month, same-day settle prices may differ, move by different amounts and in opposite directions from forward-settle prices. The difference between an index price and a forward-settle price generally follows a predictable pattern. Month-to-date total returns using same-day settle prices are generally much smoother than month-to-date forward-settle-based total returns. So, at some points in a month, there can be a significant difference between the month-to-date price return calculated under each settlement assumption. Consequently, depending on the index replication strategy and pricing convention, the month-to-date return of the strategy may not track the index very closely intra-month, but may still converge by month's end. This can lead to tracking error if the replication portfolio uses forward-settle pricing while the index uses same-day settle pricing.

[6] Paydown return captures the gain or loss when a percentage of a security's par amount outstanding is redeemed and the security is trading at a price other than par. On the first business day of the month, paydowns are estimated for each index generic using the prior month's calculated survival rate (based on the actual conditional prepayment rate or CPR). These estimated values are replaced by the actual values on the sixteenth business day of the month when the amount outstanding of MBS generics is updated to reflect the net principal paid down and new issuance of underlying pools.

[7] The entity that originally set this schedule, the Public Securities Association, or PSA, merged with the Securities Industry Association in 2006 to create SIFMA.

MBS Replication Strategies Using TBAs

Although TBAs are not part of the index, TBAs do track the performance of the benchmark's underlying generics. Using non-index instruments to track an index is not unusual; investors have long used Treasury futures, CDX swaps, and interest-rate swaps to track various other index returns.

REMIX was originally developed to enable European investment managers with limited US MBS experience to satisfy client requests for a benchmark change from the Euro Aggregate Index to the multi-currency Global Aggregate Index. Since 2001, REMIX usage continues to grow from a wide array of investors: non-US and US, portfolio managers (both active and passive), central banks, official institutions, public pension plans managing assets in-house, and hedge funds looking to port their alpha onto an index beta. Given the difficulty of earning significant active returns in the MBS sector, US Aggregate Index managers use REMIX to achieve "beta" exposure to the MBS portion of their benchmark, while employing more aggressive "alpha" strategies in other sectors they perceive to have higher return potential. Although REMIX is a long-only portfolio, investors can sell REMIX's TBA positions to effectively short the MBS Index.

The TBA Market

On the trade date, counterparties to a TBA contract agree only on the guaranteeing agency, maturity, coupon, current face amount, price and forward settlement date (e.g., A agrees to buy $50 million of 5% FNMA 30-year pools from B, at a price of $102-3, for settlement on next month's forward settlement date). Because TBAs are forward contracts, little or no cash outlay is required until settlement.[8] By standardizing the deliverable terms and concentrating settlement at a single nearby forward date, the TBA market has become a liquid and important secondary market. For mortgage originators, the TBA market serves a critical function by allowing them to hedge and fund their origination pipelines. For investors, TBA market liquidity makes it relatively easy to add or subtract MBS market exposure.

Details (including WAC, WALA, average loan size, and geographic concentration) of the specific pools to be delivered to the TBA buyer are made available on Notice Day, which is two days prior to settlement date. The TBA seller has the option of which pool(s) to deliver against his short TBA position, provided that the pools satisfy the agency, maturity, and coupon stipulations in the TBA contract. Optimal delivery for the TBA seller is the least attractive pools that are the cheapest to buy, generally exhibiting the worst prepayment characteristics. For this reason, the underlying deliverable pools to a TBA contract are often referred to as the "worst-to-deliver" or "cheapest-to-deliver."

[8] As part of the collateral service agreement a firm signs with a broker-dealer, margin may be required to periodically mark positions to market.

TBA Rolls

As the end of a TBA contract approaches, the buyer can choose to "roll" his TBA position by closing out the current month's position and entering into a new position for settlement in the following month. The TBA price for settlement in the next month is generally slightly lower than the TBA price for settlement in the current month. This price difference (the "drop") reflects the net carry difference between settling the trade this month (and receiving a coupon payment and any principal that has paid down as holder of record at month-end) and postponing settlement (and investing the cash that would have been used for this month's settlement). The drop may have a "technical" component as well, arising from imbalances in the current month's supply and demand. For example, mortgage originators may need to sell their current and anticipated loan production to banks to hedge interest rate risk and lock in a price for loan origination that has not yet closed. Consequently, banks are typically overweight current production coupon MBS in the more distant forward months. To entice TBA buyers to defer taking delivery this month and agree to a more distant forward month in which the bank has more supply, the level of the drop increases to offer a "roll advantage."[9] Generally, a roll advantage exists only for current production coupons, though at times there is no roll advantage at all, and in certain situations, it may be disadvantageous for the buyer to roll.[10]

Design and Construction of the TBA Proxy Portfolio

REMIX is a rules-based portfolio of TBA contracts designed to closely track the Barclays MBS Index. REMIX selects the TBA positions (between 12 and 18 positions) and sizes them using a combination of stratified sampling, whereby the index is "bucketed" and risk exposures are matched bucket-by-bucket, and the Barclays Global Risk Model (GRM) and Optimizer.[11]

[9] Even if there appears to be a roll advantage, care must be taken to verify that the implied financing rate was correctly estimated and interpreted. In addition, the underlying characteristics of pools likely to be delivered against a TBA contract can change over time. Any roll advantage needs to be adjusted for the expected change in the quality of the pool(s) likely to be delivered. An apparent roll advantage may simply be fair compensation for rolling into a less valuable TBA deliverable. Still, a roll advantage could, at times, offer significant added return. Any roll advantage will likely produce a better TBA proxy return versus the index, but not necessarily improved tracking error volatility.

[10] This is referred to as "rolls trading cheap." The most extreme example of this market technical occurred during the 2008 financial crisis when liquidity was extremely poor and many counterparties were trying to fund their positions at a time when funding was scarce and expensive.

[11] Available via the Barclays POINT system. The REMIX methodology can generally be employed using any portfolio risk system.

REMIX is rebalanced monthly, following a set of rules intended to control turnover,[12] while ensuring that the portfolio retains high liquidity and effective tracking properties. On the first of the month, TBAs are rolled from settlement in the current month to the following month[13] using bid-side trader marks with any cash generated by the roll reinvested in the portfolio. The TBA trades assume settlement on their respective forward settlement dates, with the record date being the prior month-end. Table 30.1 shows a sample monthly REMIX portfolio.

Each month, the REMIX construction process begins by defining a "swap pool," the set of TBAs eligible for the final REMIX portfolio. Positions in the current portfolio are the starting point for the swap pool, to which is added any other TBA contract that meets the following two criteria:

1. its coupon falls within a specified range of the current daily mortgage rate less an assumed servicing fee; and
2. the market value weight of index generics (across all vintages) that correspond to the TBA for a given agency/program and coupon meets a minimum-size threshold.

Given the swap pool, the risk model and optimizer produce the REMIX portfolio. The objective of the optimization is to minimize expected TEV versus the MBS Index, while limiting the number of TBA positions in the proxy and satisfying a number of sector exposure constraints. The optimizer does not try to match coupon/program bucket exposures explicitly (which would not be possible given the limited set of TBA positions). In fact, the optimizer may deliberately overweight some coupons if the risk exposure (versus the index) from doing so helps offset other portfolio risk exposures. In normal times, when past history can be reliable in estimating future risk, this is a good way to construct an index-tracking portfolio. However, given the structural changes in the MBS market, with more possible changes on the horizon, REMIX does not rely exclusively on the optimizer and risk model. Instead, relatively tight market value constraints (i.e., bucket matching constraints) are imposed on the optimizer to ensure that the agency/program and coupon exposures in the portfolio are aligned with the index. Once REMIX is created, the risk model then estimates its expected tracking error volatility versus the index.[14]

[12] Though the TBAs will change each month to reflect a contract settling in the following month, turnover in the positions themselves (e.g., FNMA Conventional 30-year, with a 4% coupon) is relatively low (historically, around 5%).

[13] For example, the March proxy portfolio, which is rebalanced as of February month-end, includes TBAs for April settlement.

[14] For details on the Barclays risk model see: "A Portfolio Manager's Guide to Multi-Factor Fixed Income Risk Models and their Applications," Barclays Research (June 24, 2011).

Table 30.1 REMIX: TBA proxy portfolio, May 2015

			REMIX Portfolio for Fixed-Rate MBS Index							
UST 10-yr @ 2.03%										
TBA issue	FICC—JUNE TBAs	PSA Settle Date	par (OF)	WAM	WAC	OAD	WAL	PSA price	%MV	MV
FNA3%	01F03066	6/11/2015	177,310	358	3.78	6.17	10.14	101.508	9.86%	$179,983
FGB3.5%	02R03266	6/11/2015	90,638	357	4.12	5.31	9.18	104.371	5.18%	$94,599
FNA3.5%	01F03266	6/11/2015	172,833	357	4.15	5.34	9.06	104.535	9.90%	$180,672
FGB4%	02R04066	6/11/2015	94,200	350	4.61	3.68	6.81	106.547	5.50%	$100,367
FNA4%	01F04066	6/11/2015	144,877	348	4.59	3.70	7.04	106.727	8.47%	$154,623
FGB4.5%	02R04266	6/11/2015	56,828	303	4.88	2.23	5.61	108.617	3.38%	$61,725
FNA4.5%	01F04266	6/11/2015	70,802	340	5.04	2.63	5.74	108.711	4.22%	$76,970
FGB5%	02R05066	6/11/2015	102,177	268	5.60	1.43	3.80	111.063	6.22%	$113,480
FNA5.5%	01F05266	6/11/2015	68,701	259	6.12	1.28	3.41	113.078	4.26%	$77,685
FNC2.5%	01F02246	6/16/2015	120,133	178	3.06	4.59	5.70	102.313	6.74%	$122,911
FNC3%	01F03046	6/16/2015	113,283	177	3.53	4.14	5.41	104.465	6.49%	$118,341
FNC3.5%	01F03246	6/16/2015	62,803	120	3.90	2.60	3.53	106.020	3.65%	$66,584
GNB3%	21H03066	6/18/2015	113,613	358	3.62	4.47	7.44	102.582	6.39%	$116,547
GNB3.5%	21H03266	6/18/2015	137,542	357	4.02	3.36	5.82	105.227	7.93%	$144,731
GNB4%	21H04066	6/18/2015	113,666	349	4.34	2.66	4.72	106.727	6.65%	$121,311
GNB4.5%	21H04266	6/18/2015	86,860	338	4.82	2.26	4.19	108.477	5.16%	$94,223
16			**$1,726,266**			**3.77**			**100.0%**	**$5000,000,000**
Fixed-Rate MBS MAY15 Statistics Index						*3.80*				

notation:
FNA4% = 30-year FNMA 4%
FNC3% = 15-year FNMA 3%
GNB4% = 30-year GNMA II 4%
FGB4% = 30-year FHLMC 4%

Note: This REMIX portfolio was sized for a desired market value exposure of $500 mn.
Source: Barclays Research

Performance of the TBA Proxy (REMIX)

While the index return includes a price, coupon, and paydown component, the REMIX return reflects only the change in the mark-to-market of the TBA portfolio plus the return on the cash not used for settlement. While reported performance does not include transaction costs, these costs are relatively low for the large, liquid TBA market. The portfolio assumes that cash is invested in 1-month daily LIBOR, though some asset managers using REMIX might be more aggressive in their cash investments and choose short-duration assets that offer a spread over LIBOR.

REMIX has been effective in tracking the MBS Index through a diverse set of market conditions. From September 2001 to April 2015, the proxy portfolio has experienced a realized mean monthly total return difference (i.e., tracking error) against the MBS Index of 0.3 basis points (bps), with a monthly tracking error volatility (i.e., standard deviation of monthly tracking error) of 8.0 bps. Overall, the total return of the Barclays TBA proxy has been very close to the performance of the MBS Index.[15]

Figure 30.1 shows the realized monthly REMIX tracking performance, since its launch in September 2001. While average monthly tracking error has been very small, the figure shows that there have been months of large tracking errors (discussed later). Overall, however, cumulative total return (Figure 30.2) demonstrates that REMIX has tracked the MBS Index very closely since September 2001.

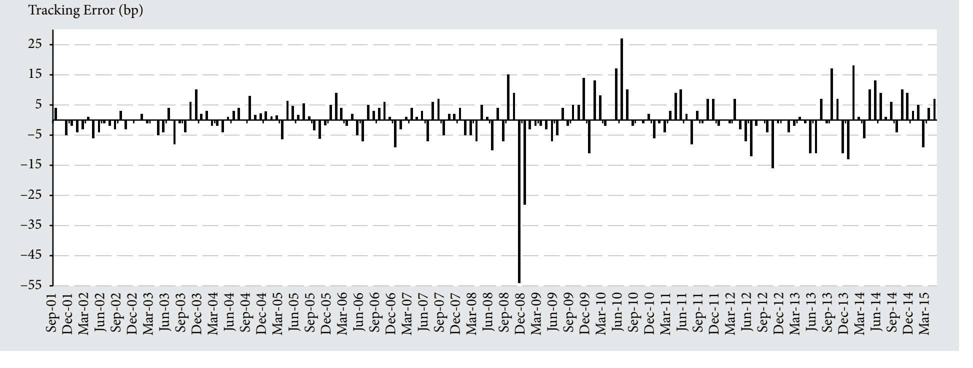

FIGURE 30.1 REMIX realized monthly tracking errors, September 2001–April 2015

Source: Barclays Research

[15] REMIX total returns are published daily on Barclays' client website, Barclays Live, and on Bloomberg via the LEHM function.

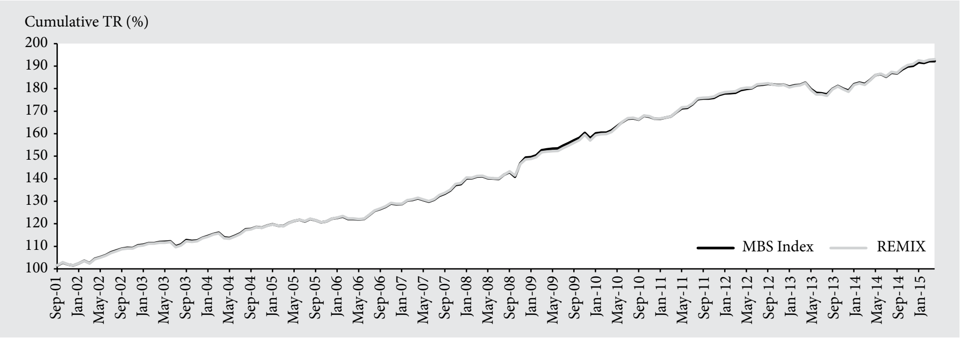

FIGURE 30.2 REMIX Cumulative performance vs MBS Index, September 2001–April 2015

Source: Barclays Research

Drivers of Realized Monthly Tracking Error

There will be some degree of tracking error from month to month. Generally, there are four main sources of tracking error: differences in pricing convention versus the index; sector and coupon allocation differences; security selection; and the impact of roll financing.

TBA vs Index Generic Pricing Convention

As discussed earlier, REMIX's performance is calculated using forward-settle prices. In contrast, the index uses same-day settle prices. Differences in these two pricing methodologies can produce tracking error between REMIX and the index.

Sector and Coupon Allocation

By design, REMIX holds relatively few positions (16 as of May 2015). As a result, there will be sector and coupon distribution mismatches between REMIX and the index. These are generally modest, at most a few percentage points of market value overweight/underweight for a particular program and coupon. However, any relative under- or overperformance of particular MBS sectors (e.g., agency, program, and coupons) can cause return differences. For example, if 30-year MBS outperforms 15-year MBS—on a duration-adjusted basis—in a given month, and REMIX is overweight the 15-year sector relative to the 30-year sector, this will tend to reduce REMIX's relative performance and produce tracking error.

Security Selection

TBAs often track new production as such pools are most likely to be delivered. Therefore, the replication strategy will generally track the recently originated part of the MBS market.[16] During periods when seasoned pools behave differently than new production pools, tracking error may result. For example, in months where interest rates rise, TBAs

[16] While a TBA market exists for coupons that fall outside of new production, that part of the TBA market tends to be less liquid.

trading below par may underperform the index as new production pools likely experience slower prepayments compared to seasoned pools of the same coupon. In market environments when rates are moving sharply, performance of new production and seasoned generics with the same program and coupon of the index may differ, leading to tracking error between REMIX and the index.

Impact of Roll Financing

REMIX rolls TBA contracts from the current month to the next. Rolling the portfolio occasionally creates a return advantage by rolling at an "implied break-even financing rate" that is less than the proxy's LIBOR cash reinvestment rate. It follows that in months where LIBOR exceeds the break-even financing rate, the proxy portfolio picks up additional return (positive tracking error) against the index. When the opposite is true, a roll disadvantage can cause underperformance (negative tracking error).

Case Study: REMIX Performance during the 2008 Financial Crisis

Figure 30.1 includes the performance of the TBA proxy portfolio during the fall of 2008, a period of dramatic developments in the financial markets, including US Federal Reserve Bank intervention in the MBS market. This period had a significant impact on TBA replication. For September and October, respectively, the proxy outperformed the benchmark by 15 bps and 9 bps, and then underperformed by 54 bps in November and 28 bps in December. We discuss the sources of these large tracking errors, as well as adjustments made to the REMIX portfolio construction process in response.

Sources of Tracking Error

The following factors contributed to performance tracking error during 2008:

1. *LIBOR*: Large changes in short-term LIBOR affect pricing of the MBS Index, which uses this rate to discount forward-settle prices back to index same-day settle prices. In contrast, the TBA portfolio uses forward-settle prices. Normally, short-term LIBOR does not move significantly during the course of one month; however, the last four months of 2008 were exceptions. For example, LIBOR dramatically rose 144 bps in September (decreasing same-day settle prices), and fell 135 bps in October (increasing index prices). From the change in LIBOR alone, the TBA Proxy outperformed by 11 bps in September and underperformed by 10 bps in October.
2. *Dealer financing*: Sharp fluctuations in broker-dealer financing costs affected the implied financing of TBA positions. The implied financing rates for TBA positions became very volatile and substantially greater than short-term LIBOR,

causing the "implicitly financed" TBA proxy to underperform versus the "non-financed" MBS Index.

3. *Position mismatches between REMIX and the index*: Between September and the end of 2008, the 2-year Treasury yield fell 120 bps and the 10-year Treasury yield fell 161 bps, with the short-end decline occurring first in September (41 bps), October (41 bps), and November (57 bps). The 10-year yield, which was largely unchanged throughout September and October, then fell sharply in November by 103 bps and December by 71 bps to all-time lows. The large yield declines and curve re-shaping had implications for the relative price movements of MBS with different coupons. Because the proxy portfolio did not have the same coupon distribution as the index, tracking error arose from large changes in relative prices for different MBS coupons.

In addition, throughout this period, the US government took actions that affected the mortgage market. In particular, on November 25, 2008, the Federal Reserve announced a large agency MBS buying program with the expressed purpose of lowering mortgage rates (and facilitating homeowner refinancing). This announcement had a significant effect on relative coupon performance with implications for REMIX tracking errors arising from coupon and agency/sector weighting differences between the proxy and index.

Ex ante versus Realized Tracking Error

Each month we use the Barclays risk model to estimate REMIX's expected tracking error volatility versus the MBS Index. Given REMIX's long performance record, it is possible to evaluate how well the risk model has predicted REMIX's tracking error volatility. The difficulty is that while the risk model produces an ex ante TEV value, we do not observe the portfolio's ex post TEV, but rather a realization of the portfolio's tracking error versus the benchmark. The predictive tracking capabilities of the risk model can be gauged by comparing the monthly realized tracking error (TE) to the month's ex ante TEV over time. To do so, we "standardize" each month's realized TE by dividing it by the risk model's TEV estimate for the proxy at the beginning of the month:

$$\text{StdTE}_t = \text{TE}_t/\text{estimated TEV}_t$$

We then examine the empirical distribution of the StdTEs, to see how often the (absolute) value is greater than one (i.e., a month's realized tracking error was more than a one-standard-deviation event); greater than two (i.e., a two-standard-deviation event), and so on. If few large standardized deviations are observed, then the risk model is doing a satisfactory job.

Figure 30.3 shows the time series of the monthly StdTEs. Aside from two months during the 2008 crisis, the TBA proxy portfolio has experienced only one other two-standard-

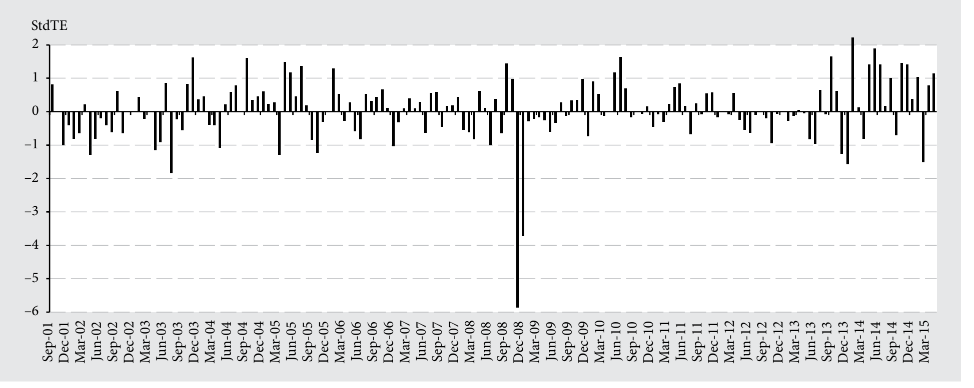

FIGURE 30.3 Standardized tracking errors (ex post TE/ex ante TEV): REMIX, September 2001–April 2015

Source: Barclays Research

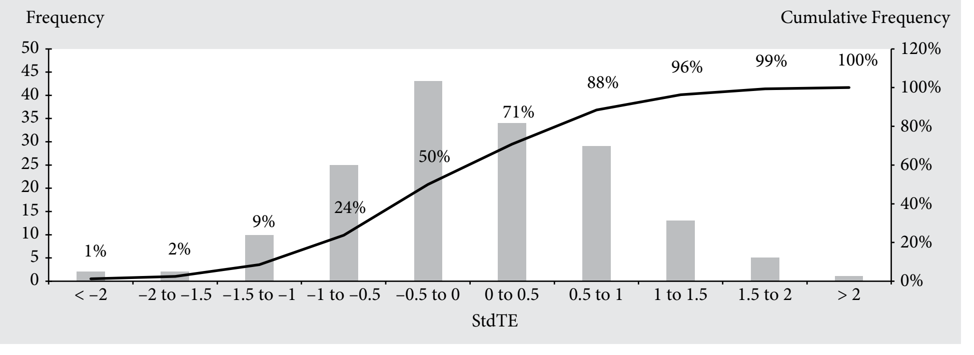

FIGURE 30.4 Frequency of standardized tracking errors, REMIX, September 2001–April 2015

Source: Barclays Research

deviation-realized tracking error event. Figure 30.4 presents the frequency distribution for the standardized tracking errors. For the Normal distribution, the expected percentage of +/− 2 standardized errors is approximately 95%. For REMIX, 98% of the StdTE were within +/− 2. Consequently, it appears that the MBS risk model has tended to be a bit conservative in its TEV estimates. However, considering the range of market environments over the period, the risk model has done a good job estimating the expected tracking performance of the TBA proxy against the MBS Index.

Average Mortgage Manager Return versus TBA Replication Proxy

REMIX experienced relatively large tracking errors through the financial crisis. However, to put its performance in perspective, we consider the return of actively managed MBS funds. While such funds are not designed to conform to the index, their returns are not expected to deviate too severely. Using a sample of 24 mortgage funds (with $241 billion in assets under management), we compared the realized

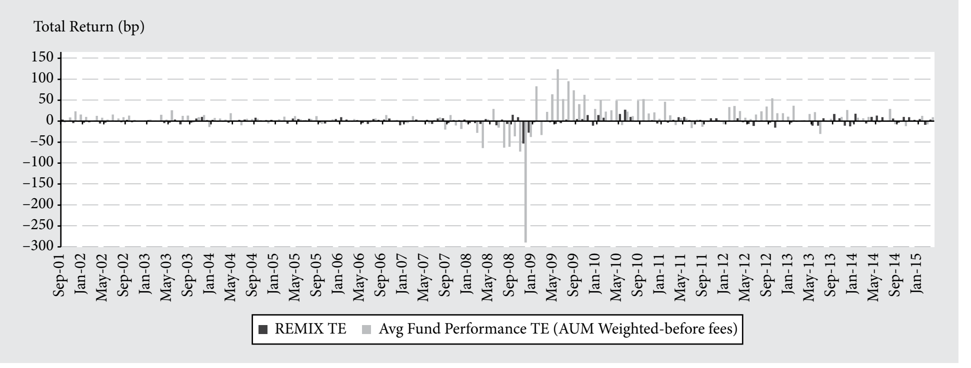

FIGURE 30.5 REMIX, average mortgage manager tracking errors, September 2001–March 2015

Source: Evestment, Barclays Research

tracking error for both REMIX and the average MBS manager over the 163 months between September 2001 and April 2015 (Figure 30.5). The average manager had a realized monthly tracking error volatility of 34.1 bps (versus 8.0 bps for REMIX), with a monthly mean return difference from the MBS Index of −6.1 bps (versus 0.3 bps for REMIX).

Subsequent Adjustments to the TBA Replication Strategy

REMIX can do little to anticipate fluctuations in broker-dealer financing (e.g., roll effect), movements in short-term LIBOR (e.g., pricing convention effects), government intervention, and changes in market demand for seasoned generics (e.g., TBA-seasoned product effects). However, in response to the events of 2008, we made several adjustments to make REMIX's tracking error performance more robust: we increased the number of positions, from 13 to about 17, and imposed tighter constraints to keep coupon and sector exposures between the proxy and the index closer. These changes, implemented in the December 2008 TBA proxy, are a precaution to help control future tracking error volatility.

Other MBS Index Replication Strategies using TBAs

Barclays maintains other TBA proxies. Investors have expressed interest in a TBA proxy portfolio with very few TBA positions. For those managers, who are typically active traders and wish to trade the MBS–Treasury basis aggressively, a portfolio with five positions ("TBA-5") is maintained. Due to the few positions, the tracking error between TBA-5 and the MBS Index can, at times, be large. Over the 89 months of TBA-5's history, this proxy has tracked the index with a realized monthly tracking error volatility of 16.7 bps and a mean return difference from the MBS Index of −0.5 bps. Customized versions of the TBA replication strategy can also be tailored to track certain segments of the MBS Index, such as Ginnie Mae or Fannie Mae MBS only.

MBS Replication Using Large Pools

For investors who cannot hold TBAs, "large pool" MBS replication is an option with relatively low transaction costs and good tracking properties. The idea behind this strategy is that if the pool size is large enough, it tends to behave more like the "average" of all the underlying pools represented by the generic in the index. Since a pool contains only a small sample of loans drawn from the population of all mortgage loans of a given coupon range, increasing the pool size increases the chance that the pool will track the generic closely. If large pools (both seasoned and recently issued) tend to track closely the "average" (e.g., generic) pool, then a strategy of buying pieces of large pools is an effective way to build a replicating portfolio. Additionally, as large pools age, they slowly start to better represent the portion of the index that is comprised of seasoned generics, which helps reduce the portfolio's overall tracking error. Large seasoned pools, however, may be difficult to find in the market, making this replication strategy difficult to implement compared to REMIX.

MBS Replication Strategies Using Total Return Index Swaps

Firms that cannot hold TBAs under their investment guidelines or simply do not wish to set up the necessary legal arrangements to do so, can opt to enter into a total return swap (TRS) for exposure to the MBS market. In a TRS, one counterparty (typically a broker-dealer) agrees to pay the return of the index in exchange for LIBOR (plus a spread), to the second counterparty (typically an asset manager). Investors in a TRS are guaranteed the index return (hence, perfect tracking) for the duration of the agreement. The downside of using a TRS, aside from its added cost in return for zero tracking error guarantee, is that it can limit the flexibility of managers with respect to inflows or withdrawals of capital. Another consideration can be the limited availability of broker-dealer counterparties that can make markets in TRS due to the legal agreements required with the benchmark provider to reference the underlying index.

Key Points

- The Barclays US MBS Index measures the Fannie Mae, Freddie Mac, and Ginnie Mae mortgage-backed passthrough security markets using "generic" positions to represent all individual settled mortgage pools of a given program, coupon, and vintage.
- Agency MBS can trade in either the specified pool market, where buyers know exactly which mortgage pools they are buying and their characteristics, or the "to-be-announced" (TBA)

market, which facilitates forward trading of agency MBS, but buyers do not know which pool(s) they will receive until shortly before delivery.

- Though TBAs are not eligible for the MBS Index, these instruments can be used by investors to effectively replicate the return of the benchmark. In general, TBA replication strategies, such as Barclays' REMIX, do not presuppose that the investor has detailed knowledge of the agency mortgage passthrough market, yet provide a relatively straightforward way to obtain an MBS market beta.
- The TBA positions in REMIX are determined using a combination of stratified sampling and the POINT Global Risk Model and Optimizer. REMIX is rebalanced on a monthly basis under construction constraints to match sector and coupon exposures between the portfolio and the benchmark.
- Since TBAs offer a "cashless" replication of MBS exposure, clients can deploy cash to other strategies with greater alpha potential or to a liquidity reserve, while still obtaining the benefits of exposure to the MBS market. Managing the REMIX portfolio also provides clients with a way to build internal MBS portfolio management capability over time, compared to entering into a total return swap or hiring an outside manager.
- Additional benefits of the replication strategy discussed in this chapter are the features of the replicating instruments themselves: the TBA market is a very liquid market which makes TBA replication relatively inexpensive. Since there is little back office overhead involved, TBA replication is also easy operationally.
- Though the replication strategy is designed to deliver the same return as the index, from month to month, tracking error between the performance of the TBA proxy and the index exists. Differences in pricing convention between TBAs and index generics, sector and coupon allocation, and security selection, as well as changes in implied roll financing costs are among the drivers of such tracking error.

Acknowledgment

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CHAPTER 31

ALTERNATIVE METHODS FOR ESTIMATING DURATION FOR MORTGAGE-BACKED SECURITIES

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After reading this chapter you will understand:

- the different types of interest rate risk: level risk and yield curve risk;
- why duration is a measure of level risk;
- the difficulties of measuring duration for an MBS;
- the price/yield relationships for MBS;
- the two general categories of duration: model duration and market duration;
- the three types of model duration (modified, cash flow, and effective duration) and their limitations;
- how effective duration is obtained using the Monte Carlo model for valuation;
- the three types of market duration (empirical duration, hedging duration, and current coupon duration), how they are computed, and how they compare to effective duration;
- how the duration of an inverse floater is determined.

A mortgage-backed security (MBS) is a bond with an embedded option. More specifically, the borrower (mortgagor) has the option to prepay the loan in whole or in part prior to the scheduled date. The cash flow from an MBS consists of interest payments, regularly scheduled principal payments, and any prepayments. A prepayment is any unscheduled principal repayment. For an agency MBS, the uncertainty regarding the future cash flow is due to prepayments, exposing an investor to prepayment risk in addition to interest rate risk. For a private-label MBS, there is credit risk in addition to prepayment risk and interest rate risk. A portfolio manager must be able to estimate a portfolio's sensitivity to changes in interest rates; that is, an estimate of the interest rate risk of a portfolio is sought in order to control the portfolio's exposure to changes in interest rates. A first approximation of the interest rate risk of a security is duration. The weighted average duration of the bonds in a portfolio gives the portfolio duration.

Unlike bonds without embedded options, the complications associated with MBS valuation using the most common methods in practice make it difficult to compute its duration. This is because the typical duration calculation requires price projections for an interest rate shock up and down. Prepayment risk as well as other assumptions that are made in MBS valuation can lead to measures that do not do an adequate job in projecting prices if interest rates are shocked, sometimes leading to substantial differences in the duration reported by dealers and computed by vendors of analytical systems.

In this chapter we explain the alternative methodologies for estimating the duration of an MBS. More specifically, an MBS portfolio is exposed to both level risk and yield curve risk. *Level risk* refers to price exposure attributable to shifts in the interest rate level (normally parallel shifts of the yield curve) while *yield curve risk* refers to changes in the shape or slope of the curve (yield curve twists). It is essential for a portfolio manager to be able to quantify the exposure to changes in interest rates in order to control that risk. In this chapter, however, our focus is on level risk. Yield curve risk, typically measured by key rate duration, is described in Chapter 24.

Price/Yield Relationship for a Mortgage Passthrough Security

There is a wide range of MBS products with different price/yield relationships. In fact, the reason for the creation of these mortgage-related products is to provide institutional investors with choices for selecting the price/yield relationship that best fits their investment objective and/or market view with respect to future interest rate movements. Here we will focus on the product that is used for the creation of mortgage derivative products—collateralized mortgage obligations (CMOs) and mortgage strips (interest-only and principal-only securities)—mortgage passthrough securities.

Figure 31.1 shows the price/yield relationships for a generic mortgage passthrough security and a Treasury security (an option-free bond). As interest rates decline, the likelihood increases that interest rates will decline further so that the borrower will benefit from refinancing. The exact interest rate level at which investors begin to view the issue likely to be refinanced may not be known, but we do know that there is some level. In Figure 31.1, at interest rate levels below y^*, the price/yield relationship for the mortgage passthrough security departs from the price/yield relationship for the Treasury security. Suppose, for example, the interest rate is such that the Treasury security would be selling for 112. However, since the passthrough is callable at par, investors would not pay 112. If they did and the passthrough is called, investors would receive 100 for a security they purchased for 112. Notice that for a range of interest rates below y^* in Figure 31.1, there is price compression; that is, there is limited price appreciation as interest rates decline. The portion of the mortgage passthrough security's price/yield relationship below y* is said to be *negatively convex*.

Negative convexity means that the price appreciation will be less than the absolute value of the price depreciation for a large change in interest rates of a given number of basis points. A Treasury security (or any option-free bond) is said to exhibit *positive convexity*; that is, the price appreciation will be greater than the price depreciation for a large change in interest rates. As can be seen from Figure 31.1, a mortgage passthrough security exhibits both positive and negative convexity.

As just mentioned, the price/yield relationship for mortgage derivatives can be quite different than for a mortgage passthrough security. Figure 31.2 compares the price/yield

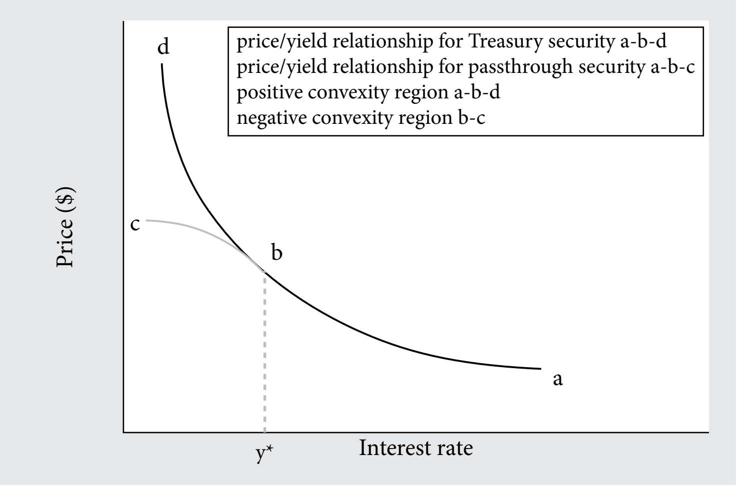

FIGURE 31.1 Price/yield relationships for mortgage passthrough security and Treasury security

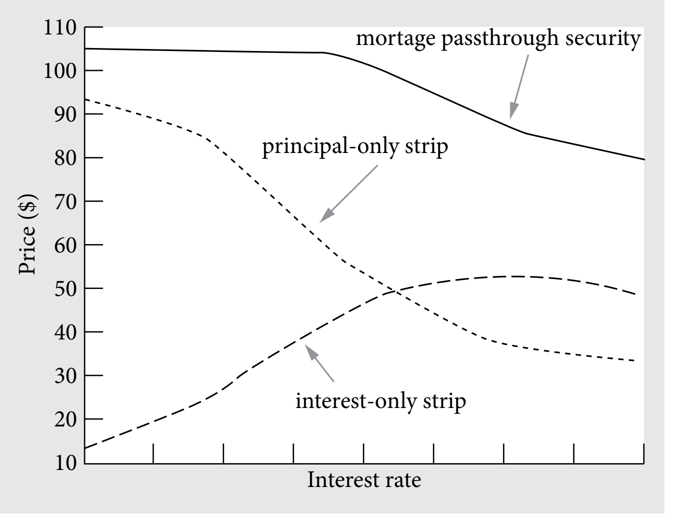

FIGURE 31.2 Price/yield relationships for mortgage passthrough security and mortgage strips

relationships for a mortgage passthrough security and two mortgage strips (interest-only and principal-only securities).

Duration

Since duration measures a bond's price sensitivity to interest rate changes, the most obvious way to measure that sensitivity is to change a bond's yield and calculate how its price will change. The basic formula for duration is:

$$\text{Duration} = \frac{V_- - V_+}{2V_0(\Delta y)} \tag{1}$$

where

Δy = change in the bond's yield (in decimal form)
V_0 = initial price of the bond (per \$100 of par value)
V_+ = the estimated value of the bond per \$100 of par value if the yield is increased by Δy
V_- = the estimated value of the bond per \$100 of par value if the yield is decreased by Δy

The two unknowns in equation (1) are the prices when the yield is increased (V_+) and decreased (V_-). The method used to determine the new prices if yields change is what distinguishes the different types of duration measures. In addition, how good the new prices are in estimating the new price determines how good the specific duration measure is in forecasting the future price change.

In implementing equation (1) it is necessary to change the bond's yield by some number of basis points (Δy). The number of basis points to use to compute the new prices is selected by the investor. There is no rule but only guidelines for how large the change should be, which we will describe later.

As we describe the different duration measures and then later discuss their potential performance in explaining price sensitivity when interest rates change, it is important to keep in mind that the performance of duration measures is really a test of the performance of valuation models used to derive the two inputs in the numerator of equation (1). Moreover, performance will depend on what interest rates (i.e., what point on the yield curve for Treasury securities) are used to determine what the estimated price change will be for a given duration measure.

A bond's duration can be interpreted as the approximate percentage change in a bond's price for a 100 basis point change in interest rates. Thus a bond with a duration of 5.2 will change by approximately 5.2% for a 100 basis point change in interest rates. For a

50 basis point change in interest rates, the bond's price will change by approximately 2.6%; for a 25 basis point change by about 1.3%, and so on.

It is also assumed that when interest rates change, the interest rates for all maturities change by the same number of basis points. Hence, duration is an interest rate risk measure that assumes a parallel shift in the term of structure of interest rates.

In general, duration measures fall into two categories: model duration and empirical duration.

Model Duration for MBS

Model duration means that the two prices used in the numerator of equation (1) are obtained from some analytical model. For MBS, model duration measures include modified duration, cash flow duration, and effective duration. The difference between these duration measures is what the model assumes happens to the cash flow if interest rates change.

Modified Duration

Modified duration is the simplest duration measure to compute but is likely to be the least reliable in many circumstances. In the calculation of the two values in the numerator of equation (1), it is assumed that the cash flow used to generate the current price is the cash flow when interest rates are shocked up and down. Thus, the bond is revalued only by using the interest rate associated with the interest rate shock (i.e., discounting the cash flow by the interest rate associated with the interest rate shock).

For example, suppose that given today's price for an MBS (V_0), the implied prepayment rate is 120 PSA. This means that a 120 PSA generates the cash flow that leads to V_0. If interest rates are shocked to obtain the two values in equation (1), V_+ and V_-, the cash flow is used based on 120 PSA but the cash flow is discounted at the new interest rate (i.e., the original yield plus the interest rate shock) to obtain these two values. The assumption being made here is that the change in interest rates will have no impact on future cash flows because it will not change prepayments.

The problem with using modified duration to estimate the interest rate sensitivity is that for an MBS that is highly prepayment-sensitive to interest rate changes, failing to recognize how the cash flow will change because prepayments change will produce a misleading estimate of duration.

The same problem with using modified duration applies to its close cousin, *Macaulay duration*. Modified duration is simply Macaulay duration divided by one plus a periodic interest rate. That is, there is a simple mathematical relationship between modified and Macaulay duration and since modified duration holds little interest to us, so does the

Macaulay duration. In a very low interest rate environment, Macaulay and modified duration are almost identical.

Cash Flow Duration

Rather than assume that the cash flow does not change when interest rates change because prepayments do not change as assumed in the computation of modified duration, it can be assumed that prepayments will change based on a new prepayment speed that reflects the interest rate change. That results in a new cash flow based on the projected prepayment speed which is then discounted at the new interest rate. When the new prices in equation (1) are computed in this manner, the resulting duration is referred to as *cash flow duration*.

For example, assume that the current prepayment rate is 120 PSA for a security. To get the two values to use in the duration formula given by equation (1), suppose the cash flow yield is shocked by 50 basis points. If the cash flow yield is increased, then a prepayment model is used to determine the new cash flow at the higher yield level. Suppose that a prepayment model indicates that at the higher yield level the prepayment speed will decline to 105 PSA. Then the cash flow for this security is generated based on 105 PSA and discounted at the current yield plus the change in interest rates. This gives the value of V_+. Suppose that if interest rates decrease by 50 basis points the prepayment model projects that the prepayment rate will increase to 135 PSA. Then the new cash flow for this security will be generated based on 135 PSA and discounted at the original yield level reduced by the change in interest rates. The resulting value for the security is V_-. Using these two values in equation (1) gives the cash flow duration.

Cash flow duration is superior to modified duration in that it at least recognizes that the cash flow may change when interest rates change. However, it still suffers from the problem that in computing the V_+ and V_- it only recognizes one possible cash flow in contrast to the valuation methodology described next.

Effective Duration

In contrast to modified duration, *effective duration* is a duration measure that assumes when interest rates change, the original cash flow will change. Unlike cash flow duration which allows for the cash flow to change when interest rates change, effective duration uses a valuation model to determine what the two prices for equation (1) are. This is done as follows. When interest rates are changed, as explained next when we describe the valuation model, a large number of potential future interest rate paths and associated cash flow patterns are used to obtain the two new prices. Because the valuation model itself takes into consideration the embedded option associated with an MBS, effective duration is also referred to as *option-adjusted duration*.

Monte Carlo Simulation Valuation Model and Effective Duration

The most common model used to value MBS is the Monte Carlo simulation model (simply Monte Carlo model, hereafter). An MBS is an interest rate path-dependent financial instrument. This means that the cash flow received in one month is determined not only by the current interest rate level, but also by the path that interest rates took to get to the current level. In the case of a mortgage passthrough security, prepayments are interest rate path-dependent because this month's prepayment rate depends on whether there have been prior opportunities to refinance since the underlying mortgages were originated. Pools of passthroughs are used as collateral for the creation of CMOs, as explained in Chapter 12. Consequently, there are typically two sources of path dependency for the cash flow of a bond class in a CMO structure: (1) the collateral prepayments are path-dependent and (2) the cash flow to be received in the current month depends on the outstanding balances of the other bond classes in the CMO structure. Thus, we need the history of prepayments to calculate these balances.

Conceptually, the valuation of a mortgage passthrough security using the Monte Carlo model is simple. In practice, however, it is very complex. The simulation involves generating a set of cash flows based on simulated future mortgage refinancing rates, which in turn imply simulated prepayment rates. Valuation modeling for CMOs is similar to valuation modeling for a mortgage passthrough security, although the difficulties are amplified because the structurer has sliced and diced both the prepayment risk and the interest rate risk into bond classes. The sensitivity of a mortgage passthrough security comprising the collateral to these two risks is not transmitted equally to every bond class. Some of the bond classes turn out to be more sensitive to prepayment risk and interest rate risk than the collateral, while some of them are much less sensitive.

Here we briefly describe the valuation process. What is critical to understand is the model assumptions. The assumptions are sources of risk in estimating duration, which collectively are referred to as *modeling risk* and thereby affect the effective duration computed.

The model involves generating random interest rate paths, taking as input today's term structure of interest rates and a volatility assumption. The term structure of interest rates is the theoretical spot rate (or zero coupon) curve implied by today's Treasury securities. Some modelers use the on-the-run Treasury issues, while others add the off-the-run Treasury issues.[1] Some modelers use the LIBOR curve instead of the Treasury curve—or give the user a choice to use the LIBOR curve. The reason is that some investors are interested in spreads that they can earn relative to their funding costs and LIBOR for many investors is a better proxy for that cost than Treasury rates.

The volatility assumption determines the dispersion of future interest rates in the simulation. Many modelers do not use one volatility number for all maturities of the

[1] The argument for using off-the-run Treasury issues is that the price/yield relationship of on-the-run Treasury issues will not reflect their true economic value because the market price reflects their value for financing purposes (i.e., an issue may be "on special" in the repo market).

yield curve. Instead, they use either a short/long yield volatility or a term structure of yield volatility. A short/long yield volatility means that volatility is specified for maturities up to a certain number of years (short yield volatility) with a different yield volatility for greater maturities (long yield volatility). The short yield volatility is assumed to be greater than the long yield volatility. A term structure of yield volatilities means that a yield volatility is assumed for each maturity.

The interest rate paths generated must be calibrated to the market. This means that the values generated from the model for on-the-run Treasury issues must equal the current market price for these issues. Each model has an assumption about how interest rates evolve over time, given the yield volatility assumption.

The simulation works by generating many scenarios of future interest rate paths. In each month of the scenario (i.e., each interest rate path), an interest rate and a mortgage refinancing rate are generated. The monthly interest rates are used to discount the scenario's projected cash flow. The mortgage refinancing rate is needed to determine the scenario's projected cash flow because it represents the opportunity cost the mortgagor is facing at that time. Prepayments are projected by feeding the refinancing rate and loan characteristics into a prepayment model. Given the projected prepayments for each month, the cash flow on an interest rate path can be projected.

Given the cash flow on an interest rate path, the path's present value can be calculated. The discount rate for determining the present value is the simulated spot rate for each month on the interest rate path plus an appropriate spread. It can be shown that these discount rates are related to the simulated rates. Thus, a present value for each interest rate path can be calculated. The present value on an interest rate path can be thought of as the theoretical value of the mortgage passthrough security if that path was actually realized. The theoretical value of the security is then determined by calculating the average of the theoretical values for all the interest rate paths.

This procedure for valuing a mortgage passthrough security is also followed for every bond class of a CMO or a mortgage strip. The cash flow for each month on each interest rate path is found according to the principal repayment and interest distribution rules of the deal.

The option-adjusted spread (OAS) is found as follows. It is the spread that must be added to all of the simulated rates that will make the theoretical value produced by the model equal to the market price.

Now that we have a general understanding of how the Monte Carlo model can be used to calculate the value of an MBS, what is of interest to us here is how this method can be used to estimate the two prices for the numerator in equation (1). This is done as follows. Consider first the price when interest rates are decreased. The original interest rate paths are then shifted accordingly and the new interest rate paths are used to determine the cash flow on the new paths. This assumes that yield volatility is unchanged. To value the MBS, the cash flow on each interest rate path is discounted at the short-term rates plus the originally computed OAS. That is, the OAS is assumed not to change. The resulting theoretical value is V_- for equation (1). The same procedure is used to get V_+ for equation (1) when interest rates are increased.

Effective Duration and the Underlying Assumptions

We have just seen how effective duration is computed and this will help us understand the reason that there are differences in the effective durations reported by dealers and vendors of analytical services. This is because the assumptions employed in the Monte Carlo model impact how well effective duration predicts price changes when interest rates change. There have been studies that seek to explain why and illustrate how these differences occur. Probably the two most well-known studies are by Choi[2] and Hayre and Chang,[3] both in the mid-1990s but still relevant today. We will now discuss the findings of these two studies.

Choi offers the following four reasons for the differences among the reported effective durations of dealers and vendors:[4]

1. differences in the amount of the interest rate shock used;
2. directional bias versus nondirectional bias rate shock;
3. differences in prepayment models;
4. differences in OAS.

As explained earlier, the interest rate shock is the number of basis points by which interest rates are increased and decreased in order to obtain the two values in the numerator of equation (1). Using an interest rate shock that is too large causes a problem with picking up the impact of convexity. Using a small rate shock such as 1 or 10 basis points introduces a different problem, which is that the error realized in estimating the new prices is amplified because of the division by a small number in the denominator in equation (1).

A directionally biased effective duration means that in computing effective duration only the price change resulting from one interest rate shock (up or down) is used instead of prices from both an up and down interest rate shock. The direction of the bias for the interest rate will depend on the investor's objective. If the concern is with a rise in interest rates on a long position, an increase in interest rates may be used to determine the effective duration. However, in the case of some MBS, the motivation for using a directional bias is due to the fact that some mortgage-related products and certain high-coupon mortgage passthrough securities exhibit a price/yield relationship that is not monotonically increasing or decreasing within a certain range. This is shown in Figure 31.3 for an interest-only (IO) strip. As indicated in the figure, the effective duration would be different if the prices used were based on (1) an interest rate shock that is either an increase or a decrease only and (2) an average for up and down interest rate shocks. In the latter case, the computed effective duration would suggest that the price

[2] Sam Choi, "Effective Durations for Mortgage-Backed Securities: Recipes for Improvement," *Journal of Fixed Income* 5/4 (1996), 23–31.

[3] Lakhbir S. Hayre and Hubert Chang, "Effective and Empirical Durations of Mortgage Securities," *Journal of Fixed Income* 6/4 (1997), 17–33.

[4] Choi, "Effective Durations for Mortgage-Backed Securities: Recipes for Improvement," 24.

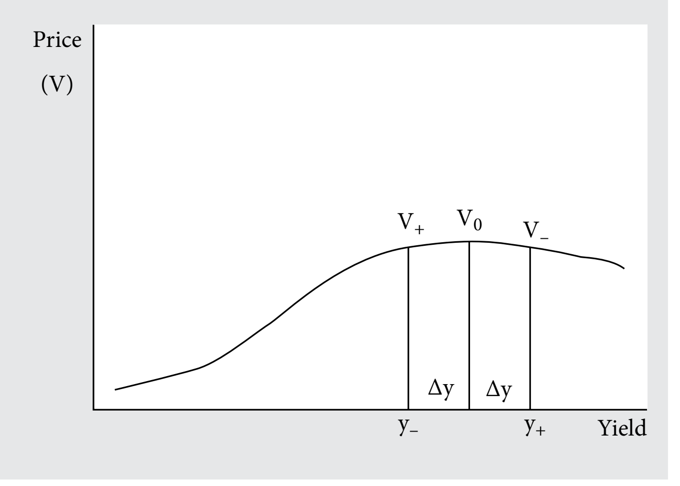

FIGURE 31.3 Price/yield relationship for an interest-only stripped mortgage security

decreased in both the up and down interest rate shock scenarios. This suggests that computed effective duration would be misleading in this case.

Dealers and analytical vendors seek to differentiate themselves by their prepayment models. Some dealer/vendor models consistently forecast fast prepayment rates relative to other dealer/vendor models and others the reverse. If the prepayment rates that are forecasted are too fast, the effective duration will be lower than if slower prepayment rates are projected. The reverse is the situation for prepayment rates that are too slow—the effective duration will be greater.

Now let's look at the fourth reason given by Choi for the difference in effective durations reported by dealers/vendors. As explained in the description of the Monte Carlo model and how effective duration is computed using it, the effective duration is dependent on the OAS computed. There are two problems that arise. First, recall that the calculation of the OAS is a byproduct of the Monte Carlo model. Therefore, the computed value for the OAS depends on all of the assumptions in the Monte Carlo model. Specifically, it depends on the yield volatility assumed and the prepayment model employed. Dealers and vendors make different assumptions regarding yield volatility and use proprietary prepayment models. These can result in differences in OAS. The second problem is that even if the OAS values computed by all dealers and vendors are identical, the effective durations may not do well in forecasting future price changes because of the assumption in calculating the projected prices computed from the Monte Carlo model that are used when interest rates are shocked up and down. Recall that the assumption is that when interest rates are shocked, the OAS is constant. However, market observers believe that OAS is affected by increased prepayment uncertainty and this is related to changes in interest rates.

Hayre and Chang investigated these assumptions in calculating effective duration and several others.[5] More specifically, they studied the following five assumptions:

1. a parallel shift in the yield curve;
2. a constant OAS when rates change;
3. a constant term structure of interest rate (yield) volatility;
4. a constant current-coupon/Treasury spread;
5. the absence of convexity.

Hayre and Chang analyze the prediction error for the price based on the effective duration for the FNMA 7.5s for the period June 7 to June 27, 1996 to assess the impact of these assumptions by looking at the price projected by the Monte Carlo model had the assumptions been consistent with what actually happened by June 27, 1996. The prediction error was eight ticks. They explain the prediction error in terms of the five assumptions:

1. *A parallel shift in the yield curve*: The Treasury yield curve did not change in a parallel fashion. What actually occurred is that the yield curve shifted down between June 7 and June 27 as follows: yields for the 6-month to 5-year sector of the yield curve declined by 12 basis points while at the shorter end and for maturities greater than five years, yields declined by less than 12 basis points. If the yield curve that actually occurred on June 27 been assumed on June 7, the predicted price would have been 98-11. Thus, the predicted price would indicate a price increase of 14 ticks (from 97-29 on June 7). Based on a 10-year Treasury yield decline of 7.5 basis points, it was found that there was a four-tick price increase (after adjusting for the cost of carry). Thus, the reshaping of the yield curve accounts for two ticks in the price discrepancy between the 12 ticks based on duration assuming a parallel shift and the 14 ticks due to a nonparallel shift.
2. *A constant OAS when rates change*: The constant OAS assumption when the 10-year Treasury yield changes was investigated by looking at the actual change in the OAS. On June 7, the OAS was computed to be 57 basis points. The OAS increased to 62 basis points on June 27. Had a 62 basis point OAS been assumed in computing duration on June 7 instead of 57 basis points, the projected price change would have been eight ticks lower. This is a major reason for the eight-tick discrepancy (between 12 ticks using effective duration and the four-tick actual price change).
3. *A constant term structure of interest rate (yield) volatility*: In the proprietary (dealer) model used by Hayre and Chang, a term structure of yield volatility is used. The assumption is then that the term structure of yield volatility is unchanged. A change in the term structure of yield volatility did occur between the two periods. Repricing the FNMA 7.5s on June 7 using the term structure of yield volatility on June 27, the difference in the projected price change was two ticks.

[5] Hayre and Chang, "Effective and Empirical Durations of Mortgage Securities."

4. *A constant current-coupon/Treasury spread*: In generating the refinancing rates in the Monte Carlo model, it is assumed that there is a constant spread between mortgage rates and the 10-year Treasury rate. Over the period June 7 to June 27, the spread increased by two basis points. Using the same methodology, Hayre and Chang found this to cause a 0.5 tick discrepancy.
5. *The absence of convexity*: Because of the convexity of MBS, there is an asymmetric change in price when interest rates change. Examining the price impact of this assumption, Hayre and Chang found that it had only a minimal impact on the price discrepancy, −0.1 ticks.

The actual price change after adjusting for carry was +4 ticks. The price change predicted by duration was +8 ticks. Thus, duration overestimated the price change by +4 ticks. The prediction error due to each of the assumptions is as follows:

Nonparallel yield curve shift: +2.0 ticks
Change in OAS: −8.0 ticks
Change in volatility: +2.0 ticks
Change in mortgage/Treasury spread: +0.5 ticks
Convexity: −0.1 ticks

The total impact is −3.6 ticks. That is, if all the assumptions were taken into account along with duration, the predicted price change would have been +4.4 ticks (8 ticks −3.6 ticks). This is close to the actual price change of +4 ticks.

Market-Based Duration for MBS

Market-based duration measures for an MBS use observed market prices rather than projected prices. Several approaches based on observed market prices are used to calculate duration. These market-based approaches are empirical duration, hedging duration, and coupon curve duration.

Empirical Duration

Empirical duration, sometimes referred to as *implied duration*, is the sensitivity of an MBS as estimated empirically from historical prices and yields. Regression analysis is used to estimate the relationship.[6] On a daily basis the following regression is calculated:[7]

[6] This approach was first suggested by Scott M. Pinkus and Marie A. Chandoha, "The Relative Price Volatility of Mortgage Securities," *Journal of Portfolio Management* 12/4 (Summer 1986), 9–22. The model was then refined in Paul DeRossa, Laurie Goodman, and Mike Zazzarino, "Duration Estimates on Mortgage-Backed Securities," *Journal of Portfolio Management* 18 (Winter 1993), 32–7.

[7] The model described here is the one proposed in Laurie S. Goodman and Jeffrey Ho, "Mortgage Hedge Ratios: Which One Works Best?" *Journal of Fixed Income* 7/3 (December 1997), 23–33, and Laurie S. Goodman and Jeffrey Ho, "An Integrated Approach to Hedging and Relative Value Analysis,"

$$\text{Change in mortgage price} = a + b(\text{Change in 10-year Treasury yield}) \tag{2}$$

Given the estimate of b from equation (2), the empirical duration is then calculated as follows:)

$$\text{Empirical duration} = \frac{b(\text{Change in mortgage price / Change in 10-year yield})}{\text{Full price of the MBS}} \tag{3}$$

There are advantages to using the empirical duration approach:

1. The duration estimate does not rely on any theoretical formulas or analytical assumptions.
2. Estimation of the required parameters is easy to compute using regression analysis.
3. The only inputs that are needed are a reliable price series and Treasury yield series.

The empirical duration approach has the following disadvantages:

1. A reliable price series for the mortgage security may not be available. For example, there may be no price series available for a thinly traded mortgage derivative security or the prices may be matrix-priced rather than actual transaction prices.
2. An empirical relationship does not impose a structure for the options embedded in an MBS and this can distort the empirical duration.
3. The price history may lag current market conditions. This may occur after a sharp and sustained shock to interest rates has been realized.
4. The volatility of the spread to Treasury yields can distort how the price of an MBS reacts to yield changes.

From an implementation perspective, there is no standardization as to the frequency of the data that should be used (i.e., daily, weekly, monthly), the length of the time period that should be used, and even the appropriate Treasury maturity yield that should be used. Moreover, it is not possible to calculate the empirical duration for illiquid or nonconforming MBS where little trading is performed.

Relative Performance of Empirical Duration versus Effective Duration

Studies dating back to the 1990s have examined the relative performance of effective duration and empirical duration. Typically, the analysis is based on hedging performance.

chapter 15 in Frank J. Fabozzi (ed.), *Advances in the Valuation and Management of Mortgage-Backed Securities* (New Hope, PA: Frank J. Fabozzi Associates, 1999).

Specifically, from duration estimates, hedge ratios can be constructed. The tests of relative performance look at how the duration-derived hedge ratios have performed historically.

Hayre and Chang found that in most months that they studied, effective duration outperformed empirical duration in estimating price changes. However, because they found that there were enough months where the reverse was true, they suggested that a portfolio manager should not automatically discard the information contained in empirical duration. What they did recommend was combining effective duration and empirical duration. They did not offer any specific procedure for obtaining a combined measure; it could be simply a weighted average of the two durations. They labeled the duration measure that combines effective duration and empirical duration as the *updated empirical duration*.[8] Others have also suggested combining effective duration reported by dealers and empirical duration.

Another major conclusion that Hayre and Chang reported involves the assumption of a constant OAS and attempts to incorporate the correlation between OAS and yield changes into a model for effective duration. They found that there is little relationship between this correlation and the relative performance of the two duration measures.

Goodman and Ho looked at the hedging performance of duration-derived hedge ratios using effective duration, empirical duration, and their price model duration (a type of empirical duration discussed next).[9] In contrast to the findings of Hayre and Chang, they found that effective duration does not perform as well as empirical duration measures.

In a 2011 study of empirical duration by FactSet, a regression of daily MBS price changes for generic mortgages with recent vintages at the time (2008 through 2011) against the yield changes for the 10-year Constant Maturity Treasury rate was estimated.[10] The estimated empirical durations were then compared to effective duration (using the FactSet valuation model and prepayment model described in Chapter 24). The study found that empirical duration tracked effective duration closely.

Hedging Duration

A more elaborate empirical model for estimating duration of an MBS that takes into account factors that we have noted impact its price (level of rates, shape of the yield curve, and expected interest rate volatility) has been suggested by Goodman and Ho.[11]

[8] See, for example, Douglas Breeden, "Complexities of Hedging Mortgages," *Journal of Fixed Income* 4/3 (December 1994), 6–41.

[9] Goodman and Ho, "Mortgage Hedge Ratios: Which One Works Best?" 28.

[10] Mido Shammaa, "Empirical Durations: A Tool to Gauge Mortgage Price Sensitivity" (August 30, 2011). Available at http://www.factset.com/insight/blogs/empirical-durations-a-tool-to-gauge-mortgage-price-sensitivity#.Vc4mdJfitko.

[11] Goodman and Ho, "An Integrated Approach to Mortgage Hedging and Relative Value Analysis."

The price model that they present, a special type of empirical duration model, allows not only for an estimate of the sensitivity of the price to changes in the level of rates, but also to the other factors. In their price model:

- the 10-year Treasury yield is used as a proxy for the level of rates;
- the spread between the 10-year and 2-year Treasury yields is used as a proxy for the shape of the yield curve;
- the implied 3-month yield volatility on the 10-year Treasury note is used as a proxy for expected interest rate volatility.

The price model involves estimating the following regression:

$$\begin{aligned}\text{Price} &= a + b\,(\text{10-year yield}) + c\,(\ln[\text{10-year yield}]) \\ &\quad + d\,(\text{10-year/2-year spread}) + e\,(\text{volatility})\end{aligned} \tag{4}$$

where ln[10-year yield] means the natural logarithm of the 10-year Treasury yield.

Hedging duration, also referred to as *price model duration*, is then computed as follows given the estimates for the parameters for equation (4):

$$\text{Price model duration} = -[b + c\,/\,(\text{10-year Treasury yield})] \tag{5}$$

Coupon Curve Duration

The *coupon curve duration* uses market prices to estimate the duration of an MBS. It is an easier approach to duration estimation than empirical duration but is limited in its application for the reason explained in this section.

Coupon curve duration, first suggested by Douglas Breeden,[12] starts with the coupon curve of prices for similar MBS. By rolling up and down the coupon curve of prices, the duration can be obtained. Because of the way it is estimated, this approach to duration estimation was referred to by Breeden as the "roll-up, roll-down approach." The prices obtained from rolling up and rolling down the coupon curve of prices are substituted into the duration formula given by equation (1).

To illustrate this approach, let's use the following coupon curve of prices for 30-year Ginnie Mae mortgage passthrough securities as of July 2015:

Coupon (%)	Price ($ per $100 par)
3.0	101.0000
3.5	103.9688
4.0	106.4063
4.5	108.3750
5.0	110.5625

[12] Douglas Breeden, "Risk, Return, and Hedging of Fixed-Rate Mortgages," *Journal of Fixed Income* 1/2 (September 1991), 85–107.

Suppose that the coupon curve duration for the 4s is sought. If the yield declines by 50 basis points, the assumption is that the price of the 4s will increase to the price of the 4.5s. Thus, the price will increase from 106.4063 to 108.3750. Similarly, if the yield increases by 50 basis points, the assumption is that the price of the 4s will decline to the price of the 3.5s (103.9688). Using the duration formula given by equation (1), the corresponding values are:

V_0 = 106.4063
V_- = 108.3750
V_+ = 103.9688
Δy = 0.005

The estimated duration based on the coupon curve is then:

$$\text{Current coupon duration} = \frac{108.3750 - 103.9688}{2\,(106.4063)\,(0.005)} = 4.14$$

Note that if a 100 basis points rate shock is used, the current coupon duration would be:

$$\text{Current coupon duration} = \frac{110.5625 - 101.0000}{2\,(106.4063)\,(0.01)} = 4.49$$

While two advantages of the coupon curve duration are the simplicity of its calculation and the fact that current prices embody market expectations, there are disadvantages. The approach is limited to generic MBS and TBAs but difficult to use for mortgage derivatives.

Breeden tested the coupon curve durations and found them to be relatively accurate. In a more recent study, the FactSet study noted earlier, the coupon curve duration was compared to effective duration.[13] As with empirical duration, the study found that coupon curve duration tracked effective duration well.

Duration of an Inverse Floater

A bond class commonly created within a CMO structure is an inverse floater. This bond class, discussed in more detail in Chapter 17, is a security whose coupon rate changes inversely with the change in the reference rate. It is created by splitting a fixed-rate security into a floater and an inverse floater.

The duration of an inverse floater will be a multiple of the duration of the bond class from which it is created. To see this, suppose that a 30-year fixed-rate CMO bond class with a

[13] Shammaa, "Empirical Durations: A Tool to Gauge Mortgage Price Sensitivity."

market value of $100 million is split into a floater and an inverse floater with a market value of $70 million and $30 million, respectively. Assume also that the duration for the bond class from which the floater/inverse floater combination is created is 6. For a 100 basis point change in interest rates, the value of the bond class will change by approximately 6% or $6 million (6% multiplied by $100 million). This means that by splitting the value of the bond class, the combined change in value for a 100 basis point change in interest rates for the floater and inverse floater must be $6 million. The duration of the floater is small because the reference rate resets back to the market rate every month. This means that the entire $6 million change in value must come from the inverse floater. For a $30 million par value inverse floater currently at par to change by $6 million, its duration must be 20. That is, a duration of 20 will mean a 20% change in value for the inverse floater for a 100 basis point change in interest rates and a change in value of $6 million (20% times $30 million).

Key Points

- Interest rate risk includes level risk and yield curve risk.
- Duration is a measure of a security's interest rate level risk and for an MBS there are several methods for estimating duration.
- The price/yield relationship of a mortgage passthrough security exhibits negative convexity as interest rates decline.
- The two general approaches for estimating duration are model duration and market duration.
- Model duration includes modified duration, cash flow duration, and effective duration.
- The model duration measures differ by how they compute the price of an MBS if interest rates are shocked.
- Modified duration (and Macaulay) duration are typically poor measures because they assume that when interest rates change, the cash flow (in particular, prepayments) do not change.
- Cash flow duration allows the cash flow to change when interest rates change based on a new projected prepayment rate.
- Effective duration (also called option-adjusted duration) is derived using Monte Carlo simulation for obtaining the new prices when interest rates change.
- The factors that cause differences in effective duration estimates are differences in prepayment models and yield volatility assumptions.
- The factors that may cause effective duration to perform poorly in predicting price changes when interest rates change are assumptions regarding a parallel shift in the yield curve, a constant OAS when rates change, and a constant interest rate volatility.
- Model duration is only as good as the valuation model used to obtain the forecasted prices if interest rates are changed.
- Market duration measures use market data to estimate duration rather than a valuation model.
- Market duration measures include empirical duration, hedging duration, and coupon curve duration.

- Empirical duration is estimated using regression analysis to estimate how the price change of an MBS is impacted by changes in Treasury rates.
- Hedging duration is a special case of empirical duration based on a price model.
- Coupon curve duration is computed by using the market prices to obtain the forecasted prices to use in the duration formula. This is done by rolling up and down the coupon curve of prices.
- The advantages of the empirical duration approach are (1) it does not rely on any theoretical formulas or analytical assumptions, (2) estimation of the required parameters is easy to compute using regression analysis, and (3) the only inputs needed are a reliable price series and Treasury yield series.
- The disadvantages of the empirical duration approach are (1) reliable price series for the mortgage security may not be available, (2) no empirical relationship is imposed on the structure for the options embedded in an MBS that can distort the empirical duration, (3) the price history used may lag current market conditions, and (4) the volatility of the spread to Treasury yields can distort how the price of an MBS reacts to yield changes.
- An inverse floater's duration is a multiple of the duration of the bond class from which it is created.

CHAPTER 32

HEDGING AGENCY MORTGAGE-RELATED SECURITIES

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AFTER reading this chapter you will understand:

- the different forms of interest rate risk exposure of a mortgage-related security;
- how the impact of any type of yield curve shift can be quantified using key rate durations;
- the limitations of key rate duration as a measure of yield curve risk for a mortgage-related security;
- the need to take into account how yield curves have changed historically when hedging a mortgage-related security;
- how a three-factor hedging method incorporates typical yield curve change scenarios into the hedging process;
- the limitations of a three-factor hedging method.

Because of the spread offered on agency mortgage-backed securities (MBS), they have the potential to outperform government securities with the same interest rate risk. Therefore, agency MBS can be used to generate enhanced returns relative to a benchmark when the yield advantage of MBS is attractive. However, to execute this strategy successfully, the interest rate risk of MBS, which includes the impact of interest rate movements on prepayments and MBS cash flows, must be managed carefully. The problem faced by a portfolio manager who believes that the spread offered on an MBS is attractive and wants to hedge that spread is that the price–yield relationship is sensitive to changes in both the level and shape of the yield curve.

In this chapter we will see how to "hedge" the interest rate risk associated with MBS in order to capture the spread over Treasuries. Mortgage securities have other risk factors (e.g., spread risk, volatility risk, and model prepayment risk) that investors may or may not choose to hedge, depending on their views on these risk factors. Hedging these risk factors is beyond the scope of this chapter.

Yield Curve Risk and Key Rate Duration

Duration and convexity are measures of interest rate risk for parallel shifts in interest rates. That is, if all Treasury rates shifted up or down by the same number of basis points, these measures do a good job of approximating the exposure of a security or a portfolio to a rate change. However, yield curves do not change in a parallel fashion. Consequently, portfolios with the same duration can perform quite differently when the yield curve shifts in a nonparallel fashion. Yield curve risk is the exposure of a portfolio or a security to a nonparallel change in the yield curve shape.

One approach to quantifying yield curve risk for a security or a portfolio is to compute how changes in a specific spot rate, holding all other spot rates constant, affect the value of a security or a portfolio. The sensitivity of the change in value of a security or a portfolio to a particular spot rate change is called *rate duration*. In theory, there is a rate duration for every point on the yield curve. Consequently, there is no one rate duration but a profile of rate durations representing each maturity on the yield curve. The standard duration measure is equal to the sum of the rate durations. Therefore, if all rates change by the same number of basis points, the changes in value computed from rate durations and standard duration are identical. That is, rate durations and the standard duration measure are identical for a parallel shift in the yield curve. However, vendors of analytical systems do not provide a rate duration for every point on the yield curve. Instead, they focus on key maturities of the spot rate curve. These rate durations are called *key rate durations*.

The impact of any type of yield curve shift can be quantified using key rate durations. A level shift can be quantified by changing all key rates by the same number of basis points and computing, based on the corresponding key rate durations, the effect on the value of a portfolio. The impact of a steepening of the yield curve can be found by (1) decreasing the key rates at the short end of the yield curve and determining the change in the portfolio value using the corresponding key rate durations, and (2) increasing the key rates at the long end of the yield curve and determining the change in the portfolio value using the corresponding key rate durations.

Bonds with the same duration, but with different cash flow patterns, will have different price changes if the shift in the yield curve is not parallel. For example, the value of an option-free bond with a bullet maturity payment (i.e., entire principal due at the maturity date) is sensitive to changes in the level of interest rates but not as sensitive to changes in the shape of the yield curve. This is so because for an option-free bond whose cash flow consists of periodic coupon payments but only one principal payment (at maturity), the change of rates along the spot rate curve will not have a significant impact on its value. In contrast, while the value of a portfolio of option-free bonds with different maturities is, of course, sensitive to changes in the level of interest rates, it is much more sensitive to changes in the shape of the yield curve than an individual option-free bond.

In the case of mortgage securities, the value of both an individual mortgage security and a portfolio of mortgage securities will be sensitive to changes in the shape of the yield curve, as well as changes in the level of interest rates. This is so because a mortgage security is an amortizing security with a prepayment option. Consequently, the pattern of the expected cash flows for an individual mortgage security can be materially affected by the shape of the yield curve.

For example, Thomas Ho studied the key rate duration profile for a current-coupon 30-year Ginnie Mae passthrough security and the corresponding mortgage strips—interest-only (IO) and principal-only (PO) securities.[1] At the time of his analysis, he reported that the key rate duration profile was as follows:

- The Ginnie Mae passthrough exhibits a bell-shaped curve with the peak of the curve between five and 15 years. The sum of the key rate durations from five to 15 years (i.e., the 5-year, 7-year, 10-year, and 15-year key rate durations) indicates that of the total interest-rate exposure, about 70% is within this maturity range. That is, the effective duration masks the fact that for the passthrough security, interest-rate exposure is concentrated in the 5- to 15-year maturity range.
- The PO security created from the passthrough security will have a high positive duration. However, its key rate duration profile indicates that it has slightly negative key rate durations up to year 7. Thereafter, the key rate durations are positive and have a high value. While the total risk exposure (i.e., effective duration) may be positive, there is exposure to yield curve risk. For example, the key rate durations suggest that if the long end of the yield curve is unchanged but the short end of the yield curve (up to year 7) decreases, the PO's value will decline despite an effective duration that is positive.
- The IO security created from the passthrough security has a high negative duration. However, its key rate duration profile is such that the key rate durations are slightly positive up to year 10 and then take on high negative values. As with the PO security, the IO security is highly susceptible to how the yield curve changes.

How Interest Rates Change Over Time

Key rate durations can be useful as an intuitive guide for understanding the exposure of a portfolio to different potential shifts in the yield curve, but they cannot be used to hedge yield curve risk because interest rates do not change one maturity at a time, and

[1] Thomas S.Y. Ho, "Key Rate Durations: Measures of Interest Rate Risks," *Journal of Fixed Income* 2/2 (September 1992), 29–44.

yield curve changes are not equal across maturities. An alternative approach proposed here is to investigate how yield curves have changed historically and incorporate typical yield curve change scenarios into the hedging process.

Empirically, studies have found that yield curve changes are not parallel. Rather, when the level of interest rates changes, short-term rates move more than longer-term rates. Some firms develop their own proprietary models that decompose historical movements in the rate changes of Treasury strips with different maturities in order to analyze typical or likely rate movements. The statistical technique used to decompose rate movements is either principal components analysis or factor analysis. We use principal components analysis.

Most empirical studies, published and proprietary, find that typically 95% to 98% of historical movements in rate changes can be explained by (1) changes in the overall level of interest rates, (2) changes in the slope of the yield curve (i.e., steepening and flattening), and (3) changes in the curvature of the yield curve (i.e., concave and convex).

Because of the importance of yield curve risk for mortgage securities, a hedging methodology should incorporate information about historical yield curve shifts. We will see how this is done by using a three-factor hedging methodology that we discuss next.

How to Implement Three-Factor Hedging

To create the three-factor hedge, we begin by expressing a particular mortgage security in terms of an "equivalent position" in US Treasuries (UST) or "equivalent position" in Treasury futures contracts. We identify this equivalent position by picking a portfolio of 2-, 10-, and 30-year Treasury securities or futures that has the same price performance as the mortgage security to be hedged under the assumed "level," "slope," and "curvature" yield curve scenarios. For hedging purposes, the direction of the change—up or down in the case of the "level" factor, flattening or steepening in the case of the "slope" factor, concaving and convexing in the case of the "curvature" factor—is not known.

In calculating how the price will change in response to changes in the three factors, it is assumed that the option-adjusted spread (OAS) is constant. In this way, the portfolio manager can calculate the unique quantities of 2-, 10-, and 30-year Treasury securities or futures that will simultaneously hedge the mortgage security's price response to "level," "slope," and "curvature" scenarios. This "equivalent position" in the three hedging securities is the appropriate three-factor hedge for typical yield curve shifts, and therefore defines the interest rate sensitivity of the mortgage security in terms of 2-, 10-, and 30-year Treasury securities or futures. We could also use 2-, 10-, and 30-year swaps if our goal were to hedge against swaps rather than Treasuries.

Computing the Three-Factor Hedge

The steps to compute the three-factor hedge are as follows:

Step 1. For an assumed shift in the level of the yield curve, compute prices for the mortgage security and three hedging securities, in this case UST 2-year, 10-year, and 30-year futures for (1) an assumed increase in interest rates and (2) an assumed decrease in interest rates. (The cheapest-to-deliver bond in the 30-year futures contract is often much shorter than 30 years.)

Step 2. From the prices found in step 1, calculate the price differences for the mortgage security and the three hedging instruments for the assumed shift in the level of interest rates. The price differences, which represent the average price changes, will be denoted as follows:

- MBS price_L = price difference for the mortgage security for the two level scenarios in the yield curve.
- 2-H price_L = price difference for the 2-year Treasury futures for the two level scenarios in the yield curve.
- 10-H price_L = price difference for the 10-year Treasury futures for the two level scenarios in the yield curve.
- 30-H price_L = price difference for the 30-year Treasury futures for the two level scenarios in the yield curve.

Step 3. For an assumed twist (flattening and steepening) of the yield curve, compute prices for the mortgage security and three hedging securities, i.e., UST 2-, 10-, and 30-year futures for (1) an assumed flattening of the yield curve and (2) an assumed steepening of the yield curve.

Step 4. From the prices found in step 3, calculate the price differences for the mortgage security and the three hedging instruments for the assumed twist in the yield curve. The price differences will be denoted as follows:

- MBS price_S = price difference for the mortgage security for the two slope scenarios in the yield curve.
- 2-H price_S = price difference for the 2-year Treasury futures for the two slope scenarios in the yield curve.
- 10-H price_S = price difference for the 10-year Treasury futures for the two slope scenarios in the yield curve.
- 30-H price_S = price difference for the 30-year Treasury futures for the two slope scenarios in the yield curve.

Step 5. For an assumed curvature (concaving and convexing) of the yield curve, compute prices for the mortgage security and three Treasury futures contracts for an assumed (1) concaving of the yield curve and (2) convexing of the yield curve.

Step 6. From the prices found in step 5, calculate the price differences for the mortgage security and the three hedging instruments for the assumed curvature in the yield curve. The price differences will be denoted as follows:

- MBS price_C = price difference for the mortgage security for the two curvature scenarios in the yield curve.
- 2-H price_C = price difference for the 2-year Treasury futures for the two curvature scenarios in the yield curve.
- 10-H price_C = price difference for the 10-year Treasury futures for the two curvature scenarios in the yield curve.
- 30-H price_C = price difference for the 30-year Treasury futures for the two curvature scenarios in the yield curve.

Step 7. Given the price differences computed above, we can now determine the amount to "invest" in each of the three hedging instruments by solving three simultaneous equations. Let:

- H_2 = amount of the 2-year futures per $1 of market value of the mortgage security
- H_{10} = amount of the 10-year futures per $1 of market value of the mortgage security
- H_{30} = amount of the 30-year futures per $1 of market value of the mortgage security

Our objective is to find the appropriate values for H_2, H_{10}, and H_{30} that will produce the same change in value for the three-factor hedge as the change in the price of the mortgage security that the portfolio manager seeks to hedge. The change in value of the three-factor hedge for a change in the level of the yield curve is:

$$H_2 \times (2\text{-}H\ \text{price}_L) + H_{10} \times (10\text{-}H\ \text{price}_L) + H_{30} \times (30\text{-}H\ \text{price}_L)$$

The change in value of the three-factor hedge portfolio for a slope change of in the yield curve is:

$$H_2 \times (2\text{-}H\ \text{price}_S) + H_{10} \times (10\text{-}H\ \text{price}_S) + H_{30} \times (30\text{-}H\ \text{price}_S)$$

The change in value of the three-factor hedge portfolio for a curvature in the yield curve is:

$$H_2 \times (2\text{-}H\ \text{price}_C) + H_{10} \times (10\text{-}H\ \text{price}_C) + H_{30} \times (30\text{-}H\ \text{price}_C)$$

We can now define the set of equations that equates the change in the value of the three-factor hedge with the change in the price of the mortgage security. To be more precise, we want the change in the value produced by the three-factor hedge to be in the opposite direction to the change in the price of the mortgage security. Using our notation, the three equations are:

Level:

$$H_2 \times (2\text{-}H\ \text{price}_L) + H_{10} \times (10\text{-}H\ \text{price}_L) + H_{30} \times (30\text{-}H\ \text{price}_L) = -\text{MBS price}_L$$

Slope:

$$H_2 \times (2\text{-}H \text{ price}_S) + H_{10} \times (10\text{-}H \text{ price}_S) + H_{30} \times (30\text{-}H \text{ price}_S) = -\text{MBS price}_S$$

Curvature:

$$H_2 \times (2\text{-}H \text{ price}_C) + H_{10} \times (10\text{-}H \text{ price}_C) + H_{30} \times (30\text{-}H \text{ price}_C) = -\text{MBS price}_C$$

We solve these simultaneous equations for the values of H_2, H_{10}, and H_{30}. Notice that for the three equations, all the values are known except for H_2, H_{10}, and H_{30}. Thus, there are three equations and three unknowns. A negative value for H_2, H_{10}, or H_{30} represents a short position, and a positive value for H_2, H_{10}, or H_{30} represents a long position.

Illustrations of the Three-Factor Hedge

To illustrate the steps to compute the three-factor hedge, we will examine two different mortgage securities: a mortgage passthrough and a prepayment-sensitive interest-only strip on August 7, 2015. The typical monthly interest rate changes used in our hedging examples are estimated by principal components analysis using the entire yield curve of 360 monthly zero-coupon Treasury rates. So, each principal component provides a unique change for each of the 360 rates. These changes are used to shift the entire yield curve in order to compute the price changes of the mortgages and Treasury futures. Table 32.1 shows examples of the typical monthly rate changes at three of the 360 maturities on the yield curve. Notice that changes in the "level" of rates are not constant across maturities.

Hedging Mortgage Passthrough

In this illustration we will see how to hedge a position in a Fannie Mae 3.5% coupon passthrough on August 7, 2015. The price of this mortgage security was 103.750. In our illustrations, we use the 2-, 10-, and 30-year Treasury futures as the hedging instruments for the three-factor hedge. The prevailing price for the hedging instruments was:

2-year Treasury note futures: 109.383
10-year Treasury note futures: 127.453
30-year Treasury bond futures: 158.531

Table 32.1 Change in monthly Treasury strip rates (in basis points) for three maturities used in the illustration

	Level		Slope		Curvature	
Years	Up	Down	Flattening	Steepening	Convex	Concave
2	20.1	−20.1	17.2	−17.2	4.8	−4.8
10	27.9	−27.9	1.7	−1.7	−4.6	4.6
30	22.3	−22.3	−8.5	8.5	6.2	−6.2

Table 32.2 Dollar price changes per $100 of par value for the 3.5% FNMA passthrough and the three hedging instruments

Panel a: Change in the Level of the Yield Curve

	Prices for		
Instrument	Increase for Yield	Decrease for Yield	Price Difference
3.5% FNMA passthrough	102.125	105.219	−3.094
2-year Treasury futures	108.999	109.768	−0.770
10-year Treasury futures	125.240	129.710	−4.469
30-year Treasury futures	153.136	164.165	−11.029

Panel b: Change in the Slope of the Yield Curve

	Prices for		
Instrument	Steepening	Flattening	Price Difference
3.5% FNMA passthrough	103.938	103.547	0.391
2-year Treasury futures	109.724	109.043	0.682
10-year Treasury futures	128.068	126.841	1.227
30-year Treasury futures	157.642	159.434	−1.792

Panel c: Change in the Curvature of the Yield Curve

	Prices for		
Instrument	Concave	Convex	Price Difference
3.5% FNMA passthrough	103.672	103.828	−0.156
2-year Treasury futures	109.486	109.280	0.206
10-year Treasury futures	127.240	127.666	−0.426
30-year Treasury futures	158.544	158.520	0.023

Step 1. We compute the price of the Fannie Mae 3.5% security and the prices of the three hedging instruments in both the "up" scenario and the "down" scenario for the changes in the level of interest rates based on the first principal component. The dollar price changes per $100 of par value are shown in panel a of Table 32.2. For the Fannie Mae 3.5% security, a Monte Carlo simulation model was used to calculate the prices after the changes in interest rates.[2] The OAS is held constant at its initial value in the valuation model.

Step 2. Calculate the price difference (yield increase scenario—yield decrease scenario) for each instrument resulting from the first principal component, the level change:

- MBS $\text{price}_L = -3.094$
- 2-H $\text{price}_L = -0.770$
- 10-H $\text{price}_L = -4.469$
- 30-H $\text{price}_L = -11.029$

[2] See Chapter 24 for an explanation of this approach.

Step 3. Use the second principal component to shift the yield curve and compute the prices of each instrument resulting from a change in the slope of the yield curve. The 2- to 10-year slope is assumed to change by 15.5 basis points as shown in Table 32.1. The dollar prices per $100 of par value are shown in panel b of Table 32.2. Again, a Monte Carlo simulation is used to calculate the prices of the mortgage security after shifting the yield curve for a flattening and for a steepening.

Step 4. Calculate the price difference for each instrument resulting from a change in the slope of the yield curve:

- MBS $\text{price}_S = 0.391$
- 2-H $\text{price}_S = 0.682$
- 10-H $\text{price}_S = 1.227$
- 30-H $\text{price}_S = -1.792$

Step 5. Compute the prices resulting from curvature movements in the shape of the yield curve using the third principal component. The dollar prices per $100 of par value are shown in panel c of Table 32.2.

Step 6. Calculate the price difference for each instrument resulting from a curvature shift in the yield curve:

- MBS $\text{price}_C = -0.156$
- 2-H $\text{price}_C = 0.206$
- 10-H $\text{price}_C = -0.426$
- 30-H $\text{price}_C = 0.023$

Step 7. Solve the three simultaneous equations for the hedge ratios: H_2, $H_{10,}$ and H_{30}. The change in the value of the three-factor hedge portfolio for a change in the level of the yield curve is:

$$H_2 \times -0.770 + H_{10} \times -4.469 + H_{30} \times -11.029.$$

The change in value of the three-factor hedge portfolio for a change in the slope of the yield curve is:

$$H_2 \times 0.682 + H_{10} \times 1.227 + H_{30} \times -1.792.$$

The change in value of the three-factor hedge portfolio for a curvature movement of the yield curve is:

$$H_2 \times 0.206 + H_{10} \times -0.426 + H_{30} \times 0.023.$$

The three equations that equate the change in the value of the three-factor hedge to the change in the price of the mortgage security are:

Level: $H_2 \times -0.770 + H_{10} \times -4.469 + H_{30} \times -11.029 = 3.094$
Slope: $H_2 \times 0.682 + H_{10} \times 1.227 + H_{30} \times -1.792 = -0.391$
Curvature: $H_2 \times 0.206 + H_{10} \times -0.426 + H_{30} \times 0.023 = 0.156$

Solving these simultaneous equations for the values of H_2, H_{10}, and H_{30}, we obtain:

$H_2 = -0.09453$
$H_{10} = -0.41835$
$H_{30} = -0.10438$

The value of –0.09453 for H_2 means that we will short \$0.09453 par amount in the 2-year Treasury note futures per \$1 of par amount of the mortgage security to be hedged. Thus, if the par amount of the Fannie Mae 3.5% to be hedged against interest rate risk is \$1 million, then the three-factor hedge would involve shorting:

- 2-year Treasury note futures with a notional value of \$94,530.
- 10-year Treasury note futures with a notional value of \$418,350.
- 30-year Treasury futures with a notional value of \$104,380.

Hedging a Prepayment-Sensitive IO Security

Now let's illustrate how to hedge a position in the Markit IOS.FN30.350.14 index on August 7, 2015. The index references the interest component of 3.5% coupon, 30-year Fannie Mae pools issued in 2014. The index price was 20.547. As with the previous illustration, we will use the 2-, 10-, and 30-year Treasury futures as the hedging instruments for the three-factor hedge.

We will not go through all the steps but just provide the following basic information so that the positions in the hedging instruments can be computed. Denoting the change in price by the Greek letter delta (Δ), the following was calculated:

- ΔIO $\text{price}_L = 2.984$
- ΔIO $\text{price}_S = 0.328$
- ΔIO $\text{price}_C = 0.156$

Based on this information, we can solve for H_2, H_{10}, and H_{30}. The three equations that equate the change in the value of the three-factor hedge to the change in the price of the mortgage security are:

Level: $H_2 \times -0.770 + H_{10} \times -4.469 + H_{30} \times -11.029 = -2.984$
Twist: $H_2 \times 0.682 + H_{10} \times 1.227 + H_{30} \times -1.792 = -0.328$
Curvature: $H_2 \times -0.164 + H_{10} \times 0.386 + H_{30} \times 0.372 = -0.156$

Solving these simultaneous equations for the values of H_2, H_{10}, and $H_{30,}$ we obtain:

$H_2 = -0.33240$
$H_{10} = 0.21757$
$H_{30} = 0.20561$

These values indicate that a short position will be taken in the 2-year and a long position will be taken in both 10-year and 30-year Treasury note futures. The hedge weights make sense if we compare them with the key rate duration profile as reported by Ho where he finds that IOs have positive short rate duration and negative intermediate and long rate durations.[3]

Underlying Assumptions

Now that the underlying principles and mechanics for hedging the interest rate risk of a mortgage security have been covered, let's look at the underlying assumptions for the three-factor hedge. They are:

- The yield-curve shifts used in constructing the three-factor hedge are reasonable.
- The prepayment model used does a good job of estimating how the cash flows will change when the yield curve changes.
- Assumptions underlying the Monte Carlo simulation model are realized (e.g., the interest rate volatility assumption).

Key Points

- Because of the amortizing feature and embedded prepayment option of mortgage loans, MBS have significant exposure not only to the level of interest rates but also to the shape of the yield curve (slope and curvature).
- The impact of any type of yield curve shift can be quantified using key rate durations.
- Although key rate durations can be useful as an intuitive guide for understanding the exposure of a portfolio to different potential shifts in the yield curve, they cannot be used to hedge yield curve risk because interest rates do not change one maturity at a time, and yield curve changes are not equal across maturities.
- The three-factor hedging method takes into account how yield curves have changed historically and incorporates typical yield curve change scenarios into the hedging process.
- The application of the three-factor hedging methodology for hedging the interest rate risk of an MBS involves the construction of a hedging portfolio that has the same price sensitivity to the three interest rate factors as the MBS.

Acknowledgment

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[3] Ho, "Key Rate Durations: Measures of Interest Rate Risks."

CHAPTER 33

DOLLAR ROLLS

BILL BERLINER AND ANAND BHATTACHARYA

After reading this chapter you will understand:

- what dollar rolls are and how they are used;
- the terminology used in quoting and evaluating the market;
- various ways in which rolls are evaluated;
- how rolls are used by originators, dealers, and investors;
- technical factors that affect roll markets;
- how break-even roll levels and carry are calculated;
- how the different variables associated with MBS impact roll levels;
- how the composition of the TBA market is taken into account by market participants.

Dollar rolls are a form of trade in the MBS market that enables participants to manage and finance their positions in mortgage-backed securities. Comparable to transactions in both the financial futures and repo markets, dollar rolls (or simply "rolls") facilitate the efficient operation of the to-be-announced (TBA) market. As with many types of financial transactions, rolls meet the needs of a range of market participants that either originate or invest in mortgage-backed securities (MBS). The market for rolls reflects the nature and structure of the TBA market for MBS, which developed in its current form in part to facilitate the activities of mortgage originators that need to quickly and efficiently monetize their newly funded loans.

The objective of this chapter is to provide a thorough understanding of dollar roll transactions. We will address the nature of the transactions and the reasons that different MBS market participants find them to be a useful tool in managing their positions. We discuss how the economic value of a roll is calculated, discuss why market roll levels sometimes deviate from theoretical values, and describe how different parameters and inputs impact valuations. Finally, we outline how factors impacting the TBA markets also must be taken into account by investors in calculating dollar roll values.

Dollar Roll Fundamentals

Dollar rolls are transactions in the TBA market where traders buy a quantity of MBS for one month's settlement and simultaneously sell the same face value of MBS for a different month's settlement. As "forward markets," the TBA markets are structured such that quotes are available for actively traded Fannie Mae, Ginnie Mae, and Freddie Mac coupons for a variety of settlement months.[1]

To facilitate inter-month trading activity, the market also allows dealers to quote bid and offer prices directly for rolls, which are virtually duration-neutral transactions. Dealers' quotation screens typically quote prices for three different settlement months, along with roll prices that represent trading between the first and second months' settlements and settlements in the second and third months. To illustrate the market's structure, Figure 33.1 contains a TBA screen from Thomson Reuters' Eikon system. The screen shows bid and ask prices for four Fannie Mae 30-year coupons for December, January, and February settlements, along with bid and offer prices for the December/January and January/February rolls.

Roll values are quoted as a price difference or "drop" between settlement months; as an example, if the price for FN 3.5s in February is 100-00 (par) and the price in March is 99 24/32s, the drop is 8/32s (or eight "ticks").[2] (In Figure 33.1, the Fannie 3.5 roll for December to January is quoted as a 7 7/8 tick bid and an 8 tick offer.) The market's nomenclature is that a party buying for settlement in the early (or "front" month) and selling the later ("back") month is considered to be "buying the roll," while someone selling the front month and buying the back month is "selling" it. Although it is viewed and quoted as a single transaction, a dollar roll is ultimately recorded as two separate trades. An investor looking to sell a roll would request a bid and, once the parties agree upon a drop, buy and sell prices for the two sides or "legs" are set that reflect both the drop and the approximate market levels for both months.

Roll values can be evaluated based on a few different criteria. One way is to compare the current quoted drop to the break-even roll value assuming both the funding cost and prepayment speed; a market value in excess of the break-even drop means the coupon is rolling "special."[3] (The break-even drop can also be envisioned as the net "carry" that the

[1] Forward markets are over-the-counter markets where prices are set for future delivery of an asset or commodity. While there are rules governing when and how the underlying product is delivered, there are no formal contracts as seen in futures markets.

[2] The economics of MBS ownership dictate that back-month prices are typically lower than those quoted for the front month; in rare situations where the back-month price is the higher of the two, the drop is quoted as a negative value. In futures and forward markets for commodities, by contrast, prices often rise for later settlement, reflecting storage costs and the lack of cash returns from owning the asset. This phenomenon is called "contango."

[3] In the repo market for US Treasuries, a particular security is considered "special" if demand to borrow it (normally to cover short positions) is strong enough that it is profitable for the owner to lend it out separately from their general collateral. This allows the security's owner to borrow cash at a below-market interest rate using the security as collateral.

TRADEWEB 30-YR FNMA

Cpn	Month	ΔPrice(3pm)	ΔPrice(4:45pm)	Bid	Ask	Time
2.50	Dec	+0*21	0*21	96*26	97*08	11:07
2.50	Jan	+0*21	0*21	96*19½	97*01½	11:07
2.50	Feb	+0*21	0*21	96*14	96*28	11:07
2.50	Dec/Jan	+0*00½	0*00½	0*06½	0*06¾	10:41
2.50	Jan/Feb			0*05½	0*05¾	8:03
3.00	Dec	+0*10½	0*09	100*13½	100*14½	11:35
3.00	Jan	+0*09½	0*08½	100*05½	100*06½	11:34
3.00	Feb	+0*09½	0*08½	99*31	100	11:34
3.00	Dec/Jan	+0*00⅜	0*00¼	0*07⅝	0*07¾	10:22
3.00	Jan/Feb	+0*00⅛		0*06⅜	0*06½	8:14
3.50	Dec	+0*09	0*08	103*19½	103*20½	11:36
3.50	Jan	+0*09	0*08	103*11½	103*12½	11:36
3.50	Feb	+0*09	0*08	103*04½	103*05½	11:36
3.50	Dec/Jan			0*07⅞	0*08	10:19
3.50	Jan/Feb	+0*00⅛	0*00⅛	0*07	0*07⅛	10:49
4.00	Dec	+0*07½	0*06	106*05½	106*06	11:35
4.00	Jan	+0*07	0*06	105*30	105*31	11:35
4.00	Feb	+0*07	0*05½	105*23½	105*24½	11:35
4.00	Dec/Jan	+0*00⅜	0*00¼	0*07¼	0*07⅜	10:08
4.00	Jan/Feb	+0*00¼	0*00¼	0*06⅜	0*06½	9:15

FIGURE 33.1 Sample market quotation screen for Fannie Mae TBAs

Source: Thomson Reuters Eikon and Tradeweb (used with permission)

MBS would generate over the interval of time bounded by the two settlement dates.) Alternatively, the break-even financing rate or cost-of-funds (COF) can be calculated based on the quoted value of the roll. A COF lower than a benchmark rate (e.g., the repo rate for "general collateral") indicates that the roll is special and that, by buying the security for settlement in the back month, the investor is effectively financing their holding at an advantageous rate for the holding period. Finally, roll values for coupons trading at discount or premium prices can be evaluated based on the implied break-even prepayment speed, i.e., the speed (quoted using any prepayment metric) that equates the COF to the investor's benchmark funding rate.

Before proceeding, a short discussion on TBA settlement rules and practices will be helpful. The financial industry's trade group, the Securities Industry and Financial Markets Association (SIFMA), periodically publishes a calendar of "good-day" settlement dates for MBS for each upcoming settlement month. Settlements are in turn broken out by security categories or classes, as follows:

- Class A: 30-year Fannie Mae and Freddie Mac transactions;
- Class B: 15-year Fannie Mae, Freddie Mac, and Ginnie Mae trades;
- Class C: 30-year Ginnie Mae trades; and
- Class D: All ARM trades.

The pools to be delivered into open TBA trades must be communicated by the seller to the buyer by 3:00 p.m. eastern time two business days prior to settlement for each security class. (That day is typically referenced as "notification day.") While most TBA trades are executed for good-day settlement, trades can be done for other settlement days, usually for some day late within a particular month. (This commonly occurs when originators look to liquidate their inventory of closed loans prior to the end of a month.) As noted above, quotation screens show prices for three different settlement months along with one-month rolls for the quoted months. The earliest good-day settlement month is considered the front month; after a given month's notification day has passed, the next month becomes the front month, and a new month is added to the screen. (Using Figure 33.1 as a guide, after December's notification day the screen would show January, February, and March prices and the January/February and February/March rolls.) Traders and originators looking to transact for late-month settlement (or, in fact, for any day other than good-day settlement) must calculate the value of the incremental carry using a process that is very similar to that used to evaluate rolls.

Using Dollar Rolls

MBS market participants use rolls in a variety of ways, depending on both their business model and individual strategies. Investors and dealers may buy rolls in order to take delivery of pools that they want to buy either for investment purposes or as the underlying assets (or "collateral") for agency CMO deals. Money managers will sometimes take TBA positions and continually roll them (i.e., sell the roll as settlement approaches) as a means of owning MBS and financing the investment cheaply. (As we will discuss, it can be viewed as simultaneously selling the position and buying it back at a lower price, with the proviso that the investor forgoes all cash flows.) Originators may also use rolls as a mechanism to manage the timing differences between loan fundings and the settlement dates of their hedges.

Dollar roll drops are influenced by a number of factors that impact TBA prices for both the front and back months. The price for the front month of a coupon reflects the balance between demand and supply for the MBS pools. Demand for pools is strong, for example, when CMO issuance volume is heavy, as dealers will often issue deals over the course of a month before they own all the collateral necessary to "close" them. The front-month price also reflects MBS demand from banks and depositories that want to own the product but can't hold TBAs, since they are considered by some institutions to constitute "derivatives" not allowed under their investment guidelines. There can also be upward pressure on the front-month price if there is a shortage in the supply of a coupon. For example, originators may produce less of a particular coupon if mortgage rates change quickly; this may result in a squeeze of trading desks that are short the coupon (i.e., short TBAs of the coupon in question) for that month's settlement and must close out the position by the notification date.[4] A shortfall in production of the current coupon will also force originators to transfer their open hedges to a later month by buying the roll and "pairing off" the open short positions in the front month, which also pushes the drops wider.

Dollar roll drops are also impacted by supply and demand considerations in the back month or months. A coupon's drop can expand, for instance, if there is downward pressure on prices for later settlement due to heavy supply from originators. Such supply pressures reflect the time necessary for lenders to complete the underwriting and closing processes for their "pipeline" of loan applications. When there is a short-term surge in applications, originators typically sell their production through TBA commitments for later settlement (i.e., in the second and/or third months on the screen), putting downward pressure on back-months' prices and, all else equal, pushing drops wider. Alternatively, roll values are pushed lower if numerous investors look to roll their long positions (i.e., sell the roll) during periods when a particular coupon is rolling special. The implied financing rate of a coupon is often taken into account by investors assessing the coupons they will hold as part of their MBS positions; however, a roll special is sometimes mitigated if numerous investors try to avail themselves of the same opportunity, pushing the price of the back-month TBA higher.

Dollar Roll Valuations

As opposed to roll values quoted in the market, the break-even roll value indicates the drop at which an investor would be indifferent between trading MBS for settlement in either the front or back month. There are a number of parameters that must be specified or assumed in order to calculate the break-even value of a roll.

[4] The inability to deliver against an open short position constitutes a "fail," meaning that the dealer loses the coupon interest for the duration of the fail. The party will be forced to buy the securities (and pay accrued interest) based on the later settlement date but receive accrued interest only through the original settlement date. There are also regulatory issues and fines associated with failing, particularly for persistent fails. The substantial costs associated with failing means that desks strive to close out open short positions prior to settlement even if the price of the coupon or roll is artificially boosted by a short squeeze.

1. The number of days between settlement dates. This "horizon period" impacts both the accrued interest and reinvestment cash flows generated by the transaction.
2. The number of delay days for the type of security being evaluated.
3. The coupon rate.
4. The assumed reinvestment rate.
5. The assumed age of the pools that will be delivered.
6. The assumed prepayment speed of the pools.

Investors must pay particular attention to items 4 and 5 as part of the overall assessment of roll values. As discussed in more depth in the final section of the chapter, investors must gauge what issuance year or "cohort" they will be delivered if they were to take delivery of pools for a coupon through the normal MBS allocation process. If production of a particular coupon is heavy, investors will typically assume that brand-new pools will be delivered into open TBAs; their roll calculations will then assume delivery of zero-WALA pools that will either prepay very slowly or not at all (since it typically takes a number of months for borrowers to begin to prepay their loans). If a non-production coupon is being evaluated, an investor must make some assumptions with respect to what vintage would likely be delivered against open positions, taking into account the available net float as well as the cohort's expected prepayment speed. As with other financial derivative products, investors must assume that their counterparty will deliver pools that have the least favorable characteristics which, for MBS, typically translates into undesirable prepayment behavior.[5]

Calculating Break-Even Roll Values

The calculation of roll break-evens involves comparing the value of the cash flows to be received in the front and back months. Assuming that a purchase transaction is being evaluated, the costs for the front-month settlement include principal (calculated at the front-month price) and accrued interest, as well as the opportunity cost of the purchase, i.e., the interest on the proceeds that could have been otherwise earned on the funds at the designated COF. Assuming that the securities are subsequently sold to settle at the end of the holding period (i.e., the back-month settlement date), the investor receives principal and accrued interest on the expected unpaid principal balance of the pools. In addition, the investor receives coupon interest and both scheduled and unscheduled principal paid on the pools' payment date, depending on the security traded, which is discounted at the COF.[6] The difference between the two present values, converted to a

[5] In fact, MBS traders will often refer to the cohort they expect to receive as the "cheapest-to-deliver," a term borrowed from financial futures that indicates which issue, from all securities eligible to be delivered against open contracts, has the highest implied funding costs.

[6] Note that while the recipient of the interest and principal cash flows is determined by the holder of the pools on the 30th day of the front month (i.e., the "record date"), the cash flows are not actually received by the holder until the payment date in the following month.

Table 33.1 Calculating break-even roll value given a cost of funds for 0-WALA FNMA 3.5s

1mm Initial UPB

	Price	Settlement	
Front Month	102–24	7/14/2015	
Back Month	102–15	8/13/2015	
COF/Reinvestment Rate	0.25%		
CPR	0%		
	Front Month		Back Month
Proceeds @ 102–24	$1,027,500.00	PV of Cash Flows[2]	$ 4,331.62
Accrued Interest (13 Days)	$ 1,263.89	Proceeds (UPB @ 102-15)	$1,023,237.24
Total Invested	$1,028,763.89	Accrued Interest (12 Days)	$ 1,165.02
Reinvestment Income (30 Days)[1]	$ 214.33		
Total Value—Front Month	$1,028,978.21	Total Value—Back Month	$1,028,733.88
Difference in Total Value (Front vs Back Month)	$ 244.33		
Difference for 1mm UPB	0.0244		
Break-Even Drop (Decimal)	0.2568		
(−.28125+0.0244)			
B/E Drop in 32s (Rounded)	8/32		
Roll Special	**1/32**		

Notes: [1] Calculated at 0.25% COF
[2] Cash flows include coupon payment, scheduled and unscheduled principal received on the 8/25 payment date, discounted at 0.25% COF. In the example, there is no unscheduled principal since 0% CPR is assumed.

price, is the roll's break-even value. (If a drop has been assumed, the trader will also calculate how much the break-even drop differs from the market roll value.)

The calculation is illustrated in Table 33.1, which shows the break-even roll value for new-production Fannie 3.5s based on (1) a zero prepayment assumption, (2) a COF of 0.25%, and (3) a market drop of 9/32s (i.e., 0.28125). While not shown, the calculation requires a cash flow generator in order to determine both the cash flows received on the payment date (August 25 in the example) and the UPB in the back month after all principal payments are taken into account. In the example, the cash flows received (which include one month's coupon payment and scheduled principal payment) total $4,332.

A similar calculation is performed if the break-even COF is sought given a roll value, as shown in Table 33.2. The COF used to determine the (forgone) reinvestment income is iteratively recalculated until the projected proceeds received for the front and back months are equal. The table shows that the break-even COF is below the 0.25% rate originally assumed for the COF and used for the reinvestment calculation, which indicates

Table 33.2 Calculating break-even COF given a roll value for 0-WALA FNMA 3.5s

1mm Initial UPB			
	Price	Settlement	
Front Month	102–24	7/14/2015	
Back Month	102–15	8/13/2015	
COF/Reinvestment Rate	0.25%		
CPR	*0%*		
	Front Month		Back Month
Proceeds @ 102–24	$1,027,500.00	PV of Cash Flows[2]	$ 4,331.62
Accrued Interest (13 Days)	$ 1,263.89	Proceeds (UPB @ 102-15)	$1,023,237.24
Total Invested	$1,028,763.89	Accrued Interest (12 Days)	$ 1,165.02
Reinvestment Income (30 Days)[1]	$ (30.01)		
Total Value—Front Month	$1,028,733.88	Total Value—Back Month	$1,028,733.88
Difference in Total Value (Front vs Back Month)	$ 0.00		
B/E COF	**−0.0350%**		

Notes: [1] Calculated at the B/E COF of −0.035%
[2] Cash flows include coupon payment, scheduled and unscheduled principal received on the 8/25 payment date, discounted at 0.25% COF. In the example, there is no unscheduled principal since 0% CPR is assumed.

that the roll is trading special. In this example, both the break-even COF and the reinvestment income are negative; this is commonplace at this writing, given the Federal Reserve's current policy of holding interest rates at very low levels.

Calculating MBS Carry

The calculations are similar if the economic value of carry is sought for settlement dates that are not designated by SIFMA. This calculation is often necessary after the notification date for a given month and class, when the TBA market switches to treat the following month as the new front month. Therefore, a trader looking to bid a security for "late" settlement (i.e., for settlement in the current month after good-day notification has passed) will want to calculate how much they should *add* to the quoted price for the front month. (Put differently, the trader is calculating the incremental value of settling a trade prior to the earliest SIFMA settlement date.) In this case, the desired settlement date is treated as the front-month settlement and the SIFMA settlement date is used for the back month; the trader must decide what to assume for COF, age, and prepayment speed. Table 33.3 shows an example where the break-even carry is calculated for July 25 settlement where the quoted TBA price for the next SIFMA settlement date (August 13) is 102-24, with an assumed COF of 0.375%

Table 33.3 Calculating the value of "early" settlement for 5-WALA Fannie 3.5s

	Price	Settlement	
Front Month	TBD	7/25/2015	
Back Month	102–24	8/13/2015	
COF/Reinvestment Rate	0.38%		
CPR	*3%*		
	Front Month		Back Month
Proceeds @ 102-24	$ 1,027,500.00	PV of Cash Flows[2]	$ 6,897.17
Accrued Interest (24 Days)	$ 2,333.33	Proceeds (UPB @ 102-24)	$ 1,023,409.15
Total Invested	$ 1,029,833.33	Accrued Interest (12 Days)	$ 1,162.02
Reinvestment Income (19 Days)[1]	$ 203.82		
Total Value—Front Month	$ 1,030,037.15	Total Value—Back Month	$ 1,031,468.34
Difference in Total Value (Front vs Back Month)	$ 1,431.18		
Difference for 1mm UPB	0.1431		
Value of Early Settlement (32s)	4.6		
B/E Price of Early Settlement	**102-28+**		

Notes: [1] Calculated at the COF of 0.375%
[2] Cash flows include coupon payment, scheduled and unscheduled principal received on the 8/25 payment date, discounted at 0.375% COF. In this example, the investor receives roughly $2,917 in interest, $1,450 in scheduled principal, and $2,531 in unscheduled principal.

and a prepayment assumption of 3% CPR. In the example, the value of the early settlement is approximately 4.5 ticks and the investor should pay a maximum of 102-28+ for the pool.

Factors Influencing Roll Valuations

As noted in the previous two sections, a host of parameters influence the calculation of break-even roll values and/or carry. For example, the length of the "horizon period" (i.e., number of days between settlement dates) impacts the net value of the cash flows that are included in the back-month's proceeds. A longer horizon period implies a greater break-even drop, all things equal. Another subtle factor is the payment date of the security in question. As with the calculation of MBS yields, the payment date (or, more to the point, the number of "delay" days before the investor receives principal and interest payments paid to the prior month's holder of record) varies by product type, and strongly influences the break-even value of rolls.

The coupon rate of the security being evaluated is an important driver of a roll's intrinsic value. All else equal, the break-even drop increases with the coupon, reflecting the greater coupon interest received by taking delivery of pools. The assumed reinvestment

Table 33.4 Calculating the break-even roll values for different prepayment speeds and dollar prices

Back-month UPB	
0% CPR	998,584.68
10% CPR	989,855.44

Front-Month Price = 102–24

Front-Month CFs		Back-Month CFs		
			0% CPR	10% CPR
Proceeds (102–24)	$1,027,500.00	PV of Cash Flows	$ 4,331.62	$ 13,060.14
Accrued Interest (13 Days)	$ 1,263.89	Sale Proceeds (102–24)	$1,026,045.76	$1,017,076.47
Total Invested	$1,028,763.89	Accrued Interest (12 Days)	$ 1,165.02	$ 1,154.83
Reinvestment Income	$ 214.33			
Total Value—Front Month	$1,028,978.21	Total Value—Back Month	$1,031,542.40	$ 1,031,291.43
		Difference—Front vs Back Months	$ (2,564.19)	$ (2,313.22)
		B/E Drop (Rounded 32s)	**−8**	**−7+**

Front-Month Price = 95–00

Front-Month CFs		Back-Month CFs		
			0% CPR	10% CPR
Proceeds (95–00)	$ 950,000.00	PV of Cash Flows	$ 4,331.62	$ 13,060.14
Accrued Interest (13 Days)	$ 1,263.89	Sale Proceeds (95–00)	$ 948,655.45	$ 940,362.67
Total Invested	$ 951,263.89	Accrued Interest (12 Days)	$ 1,165.02	$ 1,154.83
Reinvestment Income (0.25%)	$ 198.18			
Total Value—Front Month	$ 951,462.07	Total Value—Back Month	$ 954,152.09	$ 954,577.64
		Difference—Front vs Back Months	$ (2,690.02)	$ (3,115.57)
		B/E Drop (Rounded 32s)	**−8+**	**−10**

rate is another factor; the principal and accrued interest used for the front-month purchase is not available for the investor to otherwise invest over the horizon period and is treated as the opportunity cost of the investment.

Factors that dictate the actual cash flows to be received are critical to the calculation. Arguably, the most important parameter is the assumed prepayment speed, as it impacts both the cash flows received by the investor on the payment date and the remaining principal balance to be traded at the back-month's price. The impact of the prepayment speed assumption is, however, dependent on the price of the security, with respect to whether the security is trading at a discount or premium to parity.[7] At a premium price, a faster speed assumption reduces the break-even drop, while a faster speed increases the break-even drop for discount coupons. The impact of different prepayment assumptions is illustrated in Table 33.4, which shows break-even roll calculations for brand-new Fannie 3.5s at both 102-24 and 95-00, using prepayment assumptions of 0% and 10% CPR. While the present values of the back-month's cash flows are the same at both speeds, the faster speed reduces the UPB of the pool(s) in the back month; the projected UPBs are 998,585 and 989,855 at 0% and 10% CPR, respectively. Since the principal is returned to the investor at parity, the investor effectively loses roughly 3 points on the incremental 8,729 in principal received at the 102-24 price. By contrast, more than 4½ points are *gained* on the same amount of principal if the market price is 95-00. (Note that the investor is holding the security over the record date of July 30. If a drop is calculated within the same month and the investment is not held over month-end, the prepayment speed does not come into play.)

TBA Vintages and Roll Valuations

A complete understanding of dollar roll dynamics means that the nature of the TBA market itself should be examined. As noted, rational sellers will attempt to deliver the "cheapest–to-deliver" vintage against open forward transactions in a coupon, meaning that eligible pools with the least desirable characteristics will be delivered. This forces market participants to guess the vintage that will be delivered against their open purchases, while also judging the optimal cohort that they should deliver against forward TBA sales.

Deliveries of the current production coupon(s) will typically be made with brand-new pools. As new pools are being issued in large quantities by originators, they typically comprise the bulk of the available float in those coupons. Even if there are other vintages with significant outstanding tradable float (i.e., large outstanding balances not utilized as collateral for CMO transactions), many originators will deliver their production against their TBA sales, which in turn causes dealers to redeliver the pools against their own open forward sales. As a result, roll break-evens for production coupons are often calculated using either a 0% CPR or very slow prepayment speed, reflecting the normal lag before borrowers begin to respond to refinancing incentives.

Determining the cohort most likely to be delivered is more complex for coupons that are either in- or out-of-the-money, as well as coupons that have experienced multiple

[7] Parity is the price for MBS for which the yield is not impacted by changes in prepayment speed. It is below the security's par value (i.e., 100% of the face value) due to the impact of the payment delay.

periods of heavy issuance and thus have several vintages with significant outstanding float. In these cases, sellers will be inclined to deliver vintages that they believe will exhibit the least favorable prepayment speeds. These frequently represent issuance years that have been the most "adversely selected" due to active trading in "specified pools." During times of low mortgage rates when there is heightened refinancing activity, for example, investors will typically pay a premium for pools that have favorable attributes (such as smaller balances or higher LTVs) and are therefore expected to prepay more slowly than average. The practice of creating and selling pools that are traded outside the TBA market causes the remaining population to increasingly consist of pools with unfavorable characteristics that exhibit faster prepayments and greater refinancing responsiveness than the overall comparable population. The prevalence of this activity varies over time, depending on both investors' prepayment expectations and TBA market prices. During periods when mortgage rates were historically low and prepayment speeds were elevated, such as the fall of 2012 through much of 2013, prepayment protection was highly valued by investors, and the pay-ups for specified pools created significant incentives for originators to distribute specified pools separately from their generic production. As a result, as much as 40% of some coupons were being traded in the form of specified pools over such periods. In turn, the deliverable TBA cohorts for MBS issued during these periods were adversely selected and exhibit fast prepayment speeds relative to the total population of comparable loans issued during those periods. Assuming an adequate float, investors must assume that the more adversely selected vintages will be delivered against TBA purchases of these coupons and thus value roll break-evens on that basis.

Considering these factors, investors evaluating dollar rolls for non-production coupons must first judge the vintage(s) they can expect to receive against forward purchases and then decide on an appropriate speed assumption to use in evaluating the dollar rolls. This is especially important for those investors that want to avail themselves of below-market financing using the strategy of holding MBS positions in the form of back-month TBAs (i.e., buying TBAs and repeatedly selling the roll prior to the monthly notification days). However, market roll values often adjust to unfavorable prepayment experience; the faster expected speeds of an adversely selected coupon and vintage will weigh on roll levels and remove the rationale for this "buy and roll" strategy by making the implied funding costs unacceptably high. Roll specials for these coupons will persist only if there are other factors offsetting these fast prepayment expectations, such as heavy CMO issuance by dealers.

Key Points

- Dollar rolls are a type of trade in the MBS market where TBAs are simultaneously bought and sold for different settlement months.
- Rolls are used by mortgage originators as a tool to manage their pipeline exposures, while also allowing investors to finance their positions at rates cheaper than those available in the cash or repo markets.

- Rolls are quoted as the difference, or "drop," between prices of a given coupon for different months' settlement.
- Bid and offer levels for TBAs and rolls are quoted by dealers for settlement dates dictated by SIFMA's settlement calendar. Roll levels can also be quoted for different settlement dates (i.e., non-SIFMA "good-day" settlement), although these transactions are more subjective and offer less liquidity.
- In addition to the quoted drops, rolls can be evaluated based on the cost of funds offered by the transaction at a prepayment assumption for the holding period in question.
- Traders will also calculate the prepayment speed implied by the drop using a market cost of funds.
- Calculating the economic value of a roll requires (1) the settlement dates to be used, (2) the payment date of the security in question, (3) the pool's coupon rate and assumed age, (4) an assumed reinvestment rate, and (5) the prepayment assumption.
- The assumed prepayment speed is one of the most important parameters in the calculation of break-even roll values. However, its impact is a function of the market price of the security.
- At a discount price, a faster prepayment assumption increases the break-even value of the roll, while faster speeds compress roll valuations for premium securities.
- In gauging the value of rolls for different coupons, traders must guess the characteristics of pools that are likely to be delivered against a TBA trade. This is straightforward for production coupons (i.e., those being issued into the market), since the bulk of trading in such coupons is the newly issued cohort.
- Valuing non-production coupons requires traders to assess what vintage is likely to be delivered against open commitments, given both the current available float of the coupon and how fast different cohorts are expected to prepay.

CHAPTER 34

CREDIT DERIVATIVES AND MORTGAGE-BACKED SECURITIES

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After reading this chapter you will understand:

- the primary types of derivatives that reference mortgage-backed securities;
- how credit default swaps for mortgage-backed securities differ from corporate credit default swaps;
- how derivatives allow for the creation of synthetic collateralized debt obligations;
- the role credit derivatives can play when hedging mortgage-backed securities;
- the impact of the credit crisis on the market for credit derivatives on mortgage-backed securities;
- recent regulatory changes affecting the credit derivatives and mortgage-backed securities markets.

This chapter introduces general concepts regarding credit derivatives and shows how these derivatives are used with instruments such as *mortgage-backed securities* (MBSs). Some uses of credit derivatives in the MBS market are then discussed. Finally, we address the impact of the credit crisis on the MBS market and some recent regulatory changes.

General Overview of Credit Derivatives

Credit derivatives are a class of financial instruments that transfer the credit risk of an entity or portfolio of entities from one party to another. Credit derivatives allow investors to pursue an investment strategy (such as hedging or speculating) by taking a financial position on the credit quality of an asset or a portfolio of assets. Typically, a credit derivative's cash flows depend on events such as a default or rating downgrades. Examples of credit derivatives include single-name *credit default swaps* (CDSs), CDS indices, and synthetic *collateralized debt obligations* (CDOs).[1]

Main Characteristics

Credit derivatives can be thought of as being similar to insurance contracts, with one investor buying protection against a credit event, and the other investor selling that protection. For example, in a typical corporate CDS contract, the protection buyer makes periodic payments to the protection seller for a set length of time. In exchange, the protection seller agrees to make a payment if one of a predefined set of credit events occurs involving a specified legal entity, which is known as the "reference entity." The set of predefined credit events applicable in a CDS contract includes events such as bankruptcy or the failure to pay interest or principal. Credit derivative trades are usually *over-the-counter* (OTC) contracts that are typically based on standardized *International Swaps and Derivatives Association* (ISDA) contract terms and documentation, such as the 2003 ISDA Credit Derivatives Definitions.

Key Components of Credit Derivatives Pricing

The value, and hence the pricing, of credit derivatives is linked to credit risk. The pricing of both *plain-vanilla* and more structured credit derivatives will generally involve the estimation of a number of factors. These include the probability of default of the underlying assets or issuers over a certain time horizon, the correlations of defaults among the assets or issuers, and the expected recovery values for the assets.

Single-Name vs Multi-Name

Credit derivatives can be categorized as *single-name* or *multi-name* contracts. In a single-name credit derivative, the payoff of the security depends on the credit quality of a single underlying entity. In multi-name contracts, instead, the instrument refers to a basket or portfolio of entities (e.g., ten high-yield corporate bonds from ten separate issuers).

Tranches of Risk

A credit derivative can also be distinguished by whether the protection seller is covering all losses associated with an underlying entity or just a portion of the losses. When a derivative only covers a portion of the losses, the derivative is known as a "tranche." For tranches, the protection seller only makes payments for losses of a predefined amount and seniority associated with the underlying entity or entities.

[1] A CDO is a collection of underlying assets: for example, MBSs. The CDO is divided into several tranches of securities that have different levels of seniority: junior tranches bear more risk than senior tranches. In the case of a deterioration of the underlying pool of assets, the most senior tranches will be the last ones to suffer losses, while the most junior tranches will do so first. In order to compensate for their additional level of risk, junior tranches pay higher returns than senior tranches. See the "Synthetic ABS CDOs" section in this chapter for a further discussion of CDOs.

For example, consider a tranche CDS contract that covers 10% to 15% of the losses in an underlying basket of five CDS contracts, each with a notional value of $20 million. Thus, the protection seller makes payments when the losses exceed $10 million and are under $15 million. The most that the protection seller would have to pay is $5 million and these payments would not start until losses in the underlying portfolio had reached 10%.

Credit Derivatives Market

The market for credit derivatives started in the 1990s after J.P. Morgan structured the first transactions. By 2000, the total gross notional principal of outstanding credit derivatives contracts was approximately $800 billion.[2]

The trading of credit derivatives reached a peak in January 2008, when the estimated total gross notional of outstanding credit derivatives was at $62 trillion. In 2008, the bankruptcy of Lehman Brothers and other major financial institutions had a major impact on the market for credit derivatives.[3] The outstanding gross notional dropped from $62 trillion, at the start of the year, to under $30 trillion by the end of December 2008. By December 2014 the outstanding gross notional had fallen to $16 trillion and the net notional had fallen from $2.8 trillion to $1.8 trillion, as shown in Figure 34.1.

Banks still tend, as in the past, to be the dominant players in the credit derivatives business. Recent changes have also seen the introduction of new market participants such as central counterparties (e.g., *Intercontinental Exchange, Inc.* (ICE)). Figure 34.2 shows the buyers and sellers of credit protection as of year-end 2014. Notice that insurance and reinsurance companies, which were substantial participants a few years ago,[4] have reduced their exposure significantly.

Main MBS-Related Credit Derivatives

Single-Name CDS

Single-name CDSs are among the most common types of credit derivatives. As summarized in Figure 34.3, a protection buyer makes regular payments, usually expressed as a percentage of the notional amount of the contract, against a fixed payment amount (the par value less the recovery value of the underlying reference obligation)[5] paid by a protection seller in case of a credit event (e.g., default).

[2] Chapter 23 in John C. Hull, *Options, Futures, and Other Derivatives* (Upper Saddle River, NJ: Pearson, 2008).

[3] Kay Giesecke, "An Overview of Credit Derivatives," *Jahresbericht der Deutschen Mathematiker-Vereinigung* (2009), 57–93.

[4] See chapter 9 in Arnaud De Servigny and Olivier Renault, *Measuring and Managing Credit Risk* (New York: McGraw-Hill, 2004).

[5] The CDS is not linked to a specific bond but instead references it. That is why the security involved in the contracts is called "reference obligation." Also, the protection buyer does not necessarily have to own the underlying reference obligation of the CDS contract.

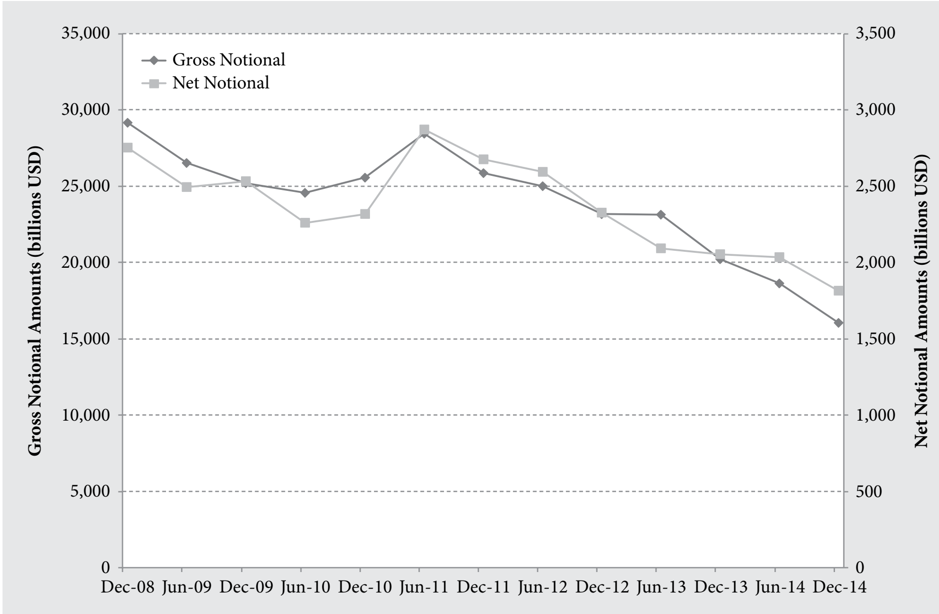


FIGURE 34.1 Credit derivatives open positions

Source: Depository Trust & Clearing Corporation (DTCC)—Trade Information Warehouse Data

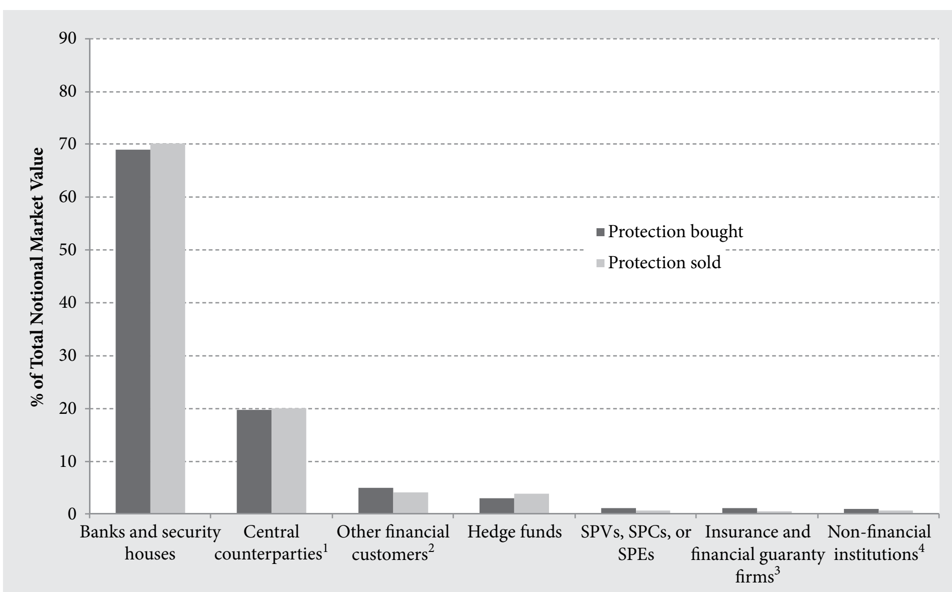


FIGURE 34.2 Buyers and sellers of CDS protection—as of December 2014

Notes: [1] An entity that interposes itself between counterparties to contracts traded in one or more financial markets, becoming the buyer to every seller and the seller to every buyer.

[2] Primarily mutual funds.

[3] Includes reinsurance and pension funds.

[4] Primarily corporate firms and governments.

Source: Bank for International Settlements (BIS) (April 2015)

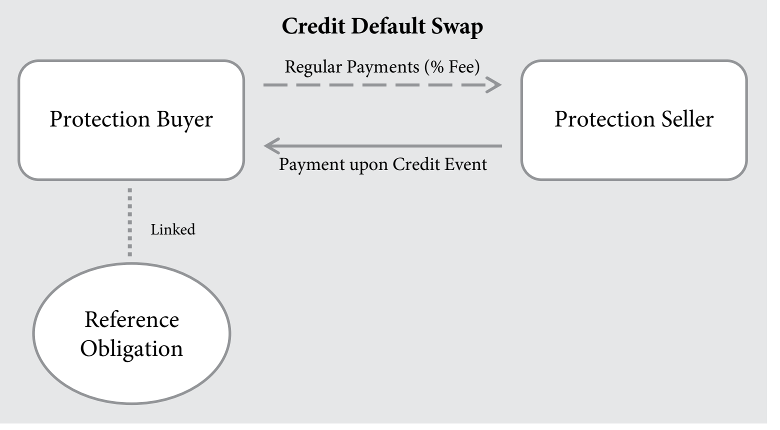


FIGURE 34.3 Credit default swap

Upon a credit event for a corporate or sovereign CDS, the contract settlement takes the form of either *physical settlement* or *cash settlement*.

For a physically settled CDS, the protection seller pays the full notional value of the contract to the protection buyer and the protection buyer delivers to the seller an obligation of the reference entity that has the same rank in the capital structure as the reference obligation of the contract. The use of any obligation with equal seniority to the reference obligation allows the protection buyer to choose which bond to deliver to the seller. This confers what is commonly referred to as the "cheapest-to-deliver" option on the protection buyer.

For a cash-settled CDS, the payoff is made in cash and the payment is equal to one minus the price (expressed as a percentage of par) of the deliverable reference obligation multiplied by the notional amount of the contract.[6]

Single-name CDS may also reference an *asset-backed security* (ABS), such as an MBS or a CDO. The mechanics of credit events are different for a CDS on an MBS or a CDO and only a specific ABS security (such as a particular tranche of an MBS) is deliverable for the CDS. However, the structure still conforms generally to the process shown in Figure 34.3. The details of the differences are discussed further in the section on Credit Default Swaps on MBS and CDOs.

CDS Indices of ABS

An ABS CDS index is a portfolio of single-name CDS on ABS. Markit administers four ABS CDS indices: ABX, CMBX, PRIMEX, and TABX.

[6] This price is determined using an auction process that is run by Creditex and Markit. Market participants submit bids at which they would be willing to buy and sell an obligation that is deliverable into the CDS. See Markit and Creditex, "Credit Event Auction Primer" for further details.

The ABX.HE is a set of tradable synthetic indices that reference twenty subprime residential mortgage-backed loan pools. Each pool of loans must have an MBS rated each of AAA, AA, A, BBB, and BBB−. In turn, each ABX.HE index has six sub-indices: penultimate AAA, AAA, AA, A, BBB, and BBB−, each of which refers to the different rated mortgage-backed security of the underlying collateral pool (there are six as there is a penultimate AAA sub-index and an AAA sub-index). For example, the ABX.HE.BBB corresponds to each of the 20 BBB-rated MBSs.[7]

In January 2006, the first ABS CDS index to be issued was the Markit ABX Home Equity Index (ABX.HE. 06-1 Index). Each vintage of the index draws from pools of subprime loans issued during a six-month period prior to the inception date of the index.[8] Markit applies specific eligibility criteria in order to select what market participants view as the most liquid obligations. For example, the 06-1 AAA sub-index represents a CDS on the AAA-rated MBSs that were issued in the second half of 2005.[9]

Originally, the index was meant to be updated (i.e., "roll") every six months, in January and in July. However, due to the lack of subprime deals in the second half of 2007, the 08-1 index and subsequent series were never issued. Hence, only four sets of ABX indices were issued: 06-1, 06-2, 07-1, and 07-2.[10]

Similar to the ABX, CMBX is an index referencing 25 subprime commercial mortgage-backed loan pools. After January 1, 2011, it encompassed six sub-indices divided by rating similarly to the ABX.HE: AAA, AS,[11] AA, A, BBB−, and BB. As intended for the ABX.HE, CMBX indices are rolled over every six months.

The PRIMEX indices are for prime *residential mortgage-backed securities* (RMBSs). The PRIMEX indices refer to 20 securitized fixed-rate (PRIMEX.FRM) or hybrid adjustable-rate (PRIMEX.ARM) pools of mortgaged loans satisfying a series of collateral and concentration criteria. Each sub-index is split into two vintage series: Series 1 for loans issued between January 2005 and July 2006 and Series 2 for loans issued between July 2006 and December 2007. The indices started to be traded in April 2010 and they represent the first tool allowing investors to short-sell prime non-agency residential mortgage-backed securities.

Finally, TABX.HE indices are tranched versions of two ABX.HE sub-indices, the BBB and BBB−, and each of them includes six different tranches.[12] The first TABX.HE index

[7] There are selection rules so that if a pool of loans has more than one mortgage-backed security with the required rating then only one would be chosen for inclusion in the ABX sub-index.

[8] Hence, the 06-1 vintage will draw loans from the second half of 2005, the 06-2 series loans from the first half of 2006, the 07-1 series loans issued in the second half of 2006, and the 07-2 series loans issued in the first half of 2007.

[9] Faten Sabry and Ethan Cohen-Cole, "The Use of ABX Derivatives in Credit Crisis Litigation," *The Journal of Structured Finance* 19/4 (Winter 2014), 22–34.

[10] These refer to January 2006, July 2006, January 2007, and July 2007 vintages, respectively.

[11] Since January 1, 2015, this requires an AAA or AA+-rated tranche with the least amount of credit enhancement if there is more than one such tranche. Before January 1, 2015, only AAA-rated tranches qualified.

[12] The attachment and detachment points for the TABX.HE BBB sub-index are: 3%, 7%, 12%, 20%, 35%, and 100%. For the TABX.HE BBB− sub-index these are: 5%, 10%, 15%, 25%, 40%, and 100%.

combined ABX sub-indices from July 2006 and January 2007; the second TABX.HE indices combined the January 2007 and July 2007 vintages. In this way, each TABX.HE sub-index references 40 subprime residential mortgage-backed loan pools (vs 20 for ABX.HE). The TABX.HE indices were launched in February 2007. Like the ABX indices upon which they are based, new TABX.HE indices are not currently being issued.

Credit Linked Notes

A *credit linked note* (CLN) is a funded credit derivative.[13] The buyer of the CLN sells protection and pre-funds the protection sold by purchasing the CLN. This is conceptually equivalent to a note or bond issued by the protection buyer. In return for selling protection, CLNs pay investors a coupon rate that incorporates, among other factors, the interest rate environment and the credit risk of the entity or entities referenced by the note.

CDS on MBS in Synthetic CDOs

Using CDS on MBS, market participants have created synthetic CDOs. A synthetic CDO is a CDO where the underlying assets are usually CDS contracts instead of cash assets,[14] and it is possible that no money is paid upfront. Like a non-synthetic CDO (often referred to as a "cash CDO" or simply a "CDO"), a synthetic CDO is a derivative that transfers the credit risk on a portfolio of assets from the CDO seller to the CDO buyer through an intermediary—a *special purpose vehicle* (SPV). This class of instruments will be discussed further in the section on synthetic ABS CDOs.

Credit Default Swaps on Mortgage-Backed Securities and Collateralized Debt Obligations

After CDSs were first used in the 1990s, the introduction of the 2003 ISDA Credit Derivatives Definitions helped standardize the contract terms used by the industry. These standard terms were useful for corporate and sovereign CDS contracts, but they were less well suited to credit derivatives that reference mortgage-backed securities and collateralized debt obligations. Standardized contract terms for both MBSs and CDOs were created to address these issues, with the most recent versions published on August 8, 2007.

[13] A funded credit derivative is one where the protection seller provides funds at trade initiation. Typically, these funds are invested by the protection buyer and can be called upon in a credit event. An unfunded credit derivative is one where the protection seller need only provide funds to satisfy a credit event after the credit event.

[14] Some CDOs can be a mix of both if the collateral pool covers both physical and synthetic assets.

Shortcomings of the 2003 Credit Derivative Definitions for MBSs and CDOs

The standardized 2003 CDS contract presented three main issues when used with an MBSs or CDO as the underlying asset. These issues were:

A Range of Securities Could Be Delivered into the CDS Contract

Corporate and sovereign CDS contracts allow for a range of bonds from the issuer in question to be delivered into the CDS contract upon a credit event. While a credit event such as bankruptcy may affect many bonds of an issuer similarly, this is not generally the case for MBSs and CDOs. When loans in a collateral pool are late with payments and/or defaulting, the cash flows for different tranches of an MBS referencing that collateral pool can be affected differently.

To solve this issue, the convention of allowing for a range of obligations to be deliverable into the CDS contract was dropped. Instead, each CDS on MBS or CDO contract specifies a specific *Committee on Uniform Security Identification Procedures* (CUSIP) or *International Securities Identification Number* (ISIN) of an issuer. The standard terms for CDS on MBS and CDO both state that Section 2.30 of the 2003 Credit Derivatives Definitions, the section that allows for bonds that are *pari passu*, among other conditions, to be deliverable into the CDS, does not apply.

Termination of the CDS Contract upon a Credit Event

If a particular tranche of a CDO or MBS experiences a credit event such as failure to pay interest and the CDS contract mirrored a corporate CDS contract, this would typically result in the CDS contract being terminated. This is often not a desirable feature for such a CDS contract. This is because for relatively junior tranches of an MBS or CDO, it is likely that there will be credit events as, even in relatively favorable economic conditions, it can be expected that some of the individual mortgages underlying the security will experience some sort of impairment. The impact of these credit events may be small relative to the overall exposure and so a buyer of protection with a CDS contract may prefer to keep the CDS contract in place.

To solve this issue, CDS contracts referencing CDOs or MBSs have adopted what is called the *pay-as-you-go framework* (PAUG). Under a PAUG-style contract, the protection buyer can be paid for two types of events, a "Floating Amount Event" and a "Credit Event." For example, if the underlying asset fails to pay principal then the protection buyer has the choice of declaring a Credit Event or a Floating Amount Event. A Credit Event declaration will result in the termination of the CDS contract and the exchange of the underlying asset for a payment equal to the outstanding notional amount covered by the contract. However, declaring a Floating Amount Event will instead result in a Floating Payment from the protection seller to the protection buyer while leaving the CDS contract intact.

Corporate Bond a CDS Contracts Did Not Accommodate the Practice of Payment-in-Kind

Some CDOs allow for *payment-in-kind* (PIK), which typically refers to the (typically temporary) payment of interest by increasing the principal amount of the tranche. This practice is not envisioned in the standard corporate CDS contract, nor even in the standard CDS on MBS contract.

The modification of the standard contract for PIK is straightforward. For CDS contracts where the underlying reference obligation is PIK-able,[15] the protection buyer may still declare a Floating Amount Event upon a Failure to Pay Interest, regardless of whether a PIK was made on the cash instrument. However, a protection buyer may not declare a Credit Event (and thereby terminate the contract resulting in a physical settlement) until at least 360 days have passed. During that time, the missed interest payment may be made on the reference obligation, and if it is, then the declaration of the Credit Event would no longer apply.

Credit Events and Floating Amount Events

A protection buyer has the flexibility to terminate the contract (by choosing to declare a Credit Event) or to not do so (by choosing to declare a Floating Amount Event) for many of the types of events. The two types of events for CDS on MBS and CDS on CDO are shown in Table 34.1.

The Writedown Event refers to the formal writedown of the principal of the underlying asset (or the subordination of principal for the purposes of interest payments). A Credit Event or a Floating Amount Event can be declared by the protection buyer when

Table 34.1 Credit and Floating Amount Events for CDS on MBS and CDO

	Floating Amount Event	Credit Event
CDS on CDO	1 Writedown 2 Failure to Pay Principal 3 Interest Shortfall	1 Writedown 2 Failure to Pay Principal 3 Failure to Pay Interest (Minimum Missed Payment Required to Declare: USD 10,000) 4 Distressed Ratings Downgrade
CDS on MBS	1 Writedown 2 Failure to Pay Principal 3 Interest Shortfall	1 Writedown 2 Failure to Pay Principal 3 Distressed Ratings Downgrade* 4 Bankruptcy* 5 Restructuring*

Note: * Events are optional and may be specified in the confirmation of the CDS trade.

[15] PIK-able is defined as allowing for "the capitalization or deferral of interest."

a writedown occurs. If a Floating Amount Event is declared, thereby not ending the CDS contract with a Credit Event, the value used to compute future fixed and floating payments for the CDS contract is reduced.[16]

Upon a missed principal payment, a protection buyer can declare either a Floating Amount Event or a Credit Event for Failure to Pay Principal. This lets the protection buyer choose whether to end the CDS contract. In contrast, upon a missed interest payment, a CDS protection buyer on an MBS can declare an Interest Shortfall as a Floating Amount Event but is not able to declare a Credit Event. A CDS protection buyer on a CDO can declare an Interest Shortfall, again as a Floating Amount Event, but may also be able to declare a Failure to Pay Interest, a Credit Event.[17] To be able to declare a Failure to Pay Interest there must have been \$10,000 in missed interest payments to date.

Reimbursement Payments

In addition to allowing for ongoing payments by the protection seller as Floating Amount Events, the PAUG contract also allows for instances where the protection buyer must pay back some of the moneys paid by the protection seller. For both CDOs and MBS, it is possible that a missed interest payment, a missed principal payment, or a writedown for the underlying asset may be made up. In such cases, a Writedown Reimbursement Amount, Principal Shortfall Reimbursement Amount, and/or an Interest Shortfall Amount will be added to the fixed payment made by the protection buyer each period.

Synthetic ABS CDOs

As previously mentioned, a synthetic CDO is a type of CDO where the underlying assets are usually CDS contracts. In this section, we provide additional information on the characteristics of synthetic CDOs.

Description and Functioning

The first synthetic CDO deals were originated in 1997. The purpose of early "bank balance sheet" deals was mainly to hedge credit risk and/or to reduce regulatory capital.

[16] If the underlying asset does not allow for any of the conditions that qualify for a writedown, an implied writedown will be used for CDS on MBS contracts and it is possible to select implied writedown in the confirmation for CDS on CDO contracts. In that case, an equivalent to a writedown amount would be computed by reference to the value of the assets backing the underlying asset.

[17] Both the CDS on CDO and CDS on MBS contracts have provisions that allow for a cap on how much the interest shortfall amount can be in any one period. These provisions are optional and are selected in the confirmation documentation of each trade.

Subsequently, "arbitrage" synthetic CDOs emerged. The primary motivation behind "arbitrage" deals was to express a view on the underlying assets of the CDO.

Synthetic CDO tranches can be either *funded* or *unfunded* and their stated maturity is typically five years.[18] If the tranche is funded, the sponsor raises capital (notional amount of the corresponding tranche) by selling notes (i.e., CLNs) to CDO investors at the beginning of the deal and, typically, purchases assets thought to be safe, such as government bonds or highly rated debt. The cash flows of these assets and the CDS are then passed to the tranche holders where each CDO investor receives a spread related to the level of seniority of the purchased tranche.

An unfunded CDO tranche is in some ways similar to a regular CDS contract: there is no upfront payment and the CDO investor only receives a credit risk spread over the lifetime of the contract.

If a credit event occurs among the reference obligations, the SPV pays the protection buyer an amount commensurate to the loss incurred. The SPV then passes the loss to investors in reverse order of seniority (i.e., losses in the reference portfolio affect the most junior tranches first and the most senior tranches last). The structure and functioning of a synthetic CDO is summarized in Figure 34.4.

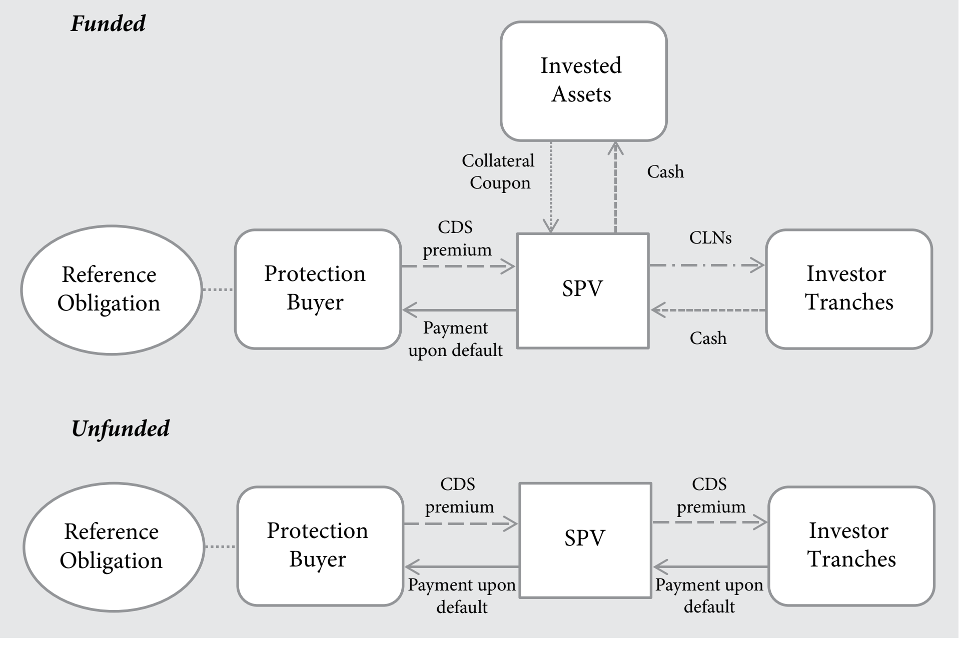


FIGURE 34.4 Synthetic CDO

[18] See chapter 9 in Arnaud De Servigny and Olivier Renault, *Measuring and Managing Credit Risk* (New York: McGraw-Hill, 2004).

Differences between Synthetic and Cash CDOs

In practice, the use of a CDS in synthetic CDOs can result in some differences with cash CDOs that go beyond the mere presence of CDSs in place of cash securities. More precisely:

- synthetic CDOs often reference a larger set of obligations than cash CDOs;
- synthetic CDOs can usually be structured more quickly than cash CDOs;
- typical synthetic CDOs have simpler structures with fewer complicated waterfalls than cash CDOs; and
- synthetic CDOs have less exposure to interest rate risk than cash CDOs.

Hedging MBS with Credit Derivatives

In general, a holder of an MBS is subject to three main types of risk: (1) the *risk of default* on the underlying mortgage loans; (2) the risk that the underlying mortgage loans will be prepaid when interest rates are lower (i.e., *prepayment risk*); and (3) the risk that interest rates will increase, leaving the investor (in an MBS paying a fixed coupon) with a portfolio of assets paying the now relatively lower fixed interest rate and that have a higher duration due to the now lower rate of prepayments.[19]

The first risk is a credit risk; the other two are related to interest rate risk. In this chapter, we will focus on the use of credit derivatives to hedge the credit risk component. The risks related to interest rates are generally hedged using Treasuries or interest rate derivatives.

ABS CDS Indices

ABS CDS indices are one of the ways to hedge non-agency MBS. For instance, ABS indices are used by investment banks to manage the credit risk they incur when underwriting securities. Underwriters usually bear credit risk in the ramp-up phase (i.e., the time during which the underlying loans are not yet placed in an MBS which has been sold to the market). An underwriter can use the ABX.HE indices to buy credit protection on a set of RMBS with a similar risk exposure as the mortgage loans in its warehouse.[20] The performance of the ABX.HE indices would hedge the performance of the warehouse loans, although the hedge would not be perfect.

As an illustration of its usefulness as a tool for hedging, the ABX.HE index has been used by banks and other market participants to assess the value of subprime mortgage

[19] International Swaps and Derivatives Association, Inc., "Disclosure Annex for Asset-Backed Security Derivative Transactions" (April 2013).

[20] Michael S. Gibson, "Credit Derivatives and Risk Management," FEDS Working Paper No. 2007-47 (2007).

portfolios. When, in December 2007, UBS wrote down its subprime mortgage investments by $10 billion, the bank used the ABX index as a reference and benchmark to value its portfolio of assets. Similarly, Morgan Stanley and Citigroup referred to ABX as a factor in the writedowns they announced in 2007.[21]

Corporate CDS Indices and Other Credit Derivatives

In addition to (or instead of) ABS indices, corporate CDS indices have been also used as hedging instruments. Although an index of corporate CDS contracts may be not as closely linked to housing-related risks as an index such as the ABX, corporate CDS indices may be easier to price and more actively traded in some cases. Thus, corporate CDS indices such as iTraxx or CDX have been used for hedging MBSs.[22]

Impact of the Credit Crisis on the ABS Credit Derivatives Market

The financial crisis affected the price of existing credit derivatives and led to a virtual standstill in the creation of new derivative indices.

Performance of ABS credit instruments during the crisis

A number of ABS securities, especially lower-rated ones, lost a substantial portion of their value during the crisis. In this section, we show the price evolution of a number of ABS credit derivatives during the financial crisis.

ABX Indices

Figure 34.5 shows the evolution of the ABX.HE index prices for each sub-index[23] of the 07-1 vintage from January 2007 to December 2013.

All of the ABX 07-1 sub-indices fell in summer 2007. For instance, the ABX.HE A 07-1 had fallen by more than 45% from June 1, 2007 to August 1, 2007. The indices continued declining in the following months. Lower-rated ABX sub-indices suffered more than the higher-rated ones. In fact, for the 07-1 vintage, all sub-indices but ABX.HE AAA had fallen to a price level below 10 by November 2008. The ABX.HE AAA performed significantly better compared to the

[21] Serena Ng, Carrick Mollenkamp, and Scott Patterson, "A 'Subprime' Gauge, in Many Ways?" *The Wall Street Journal*, December 12, 2007.

[22] See, for example, "Market Graphic: How to Hedge an ABS Portfolio," *Risk.net*, November 1, 2008.

[23] The ABX.HE Penultimate AAA was created in May 2008.

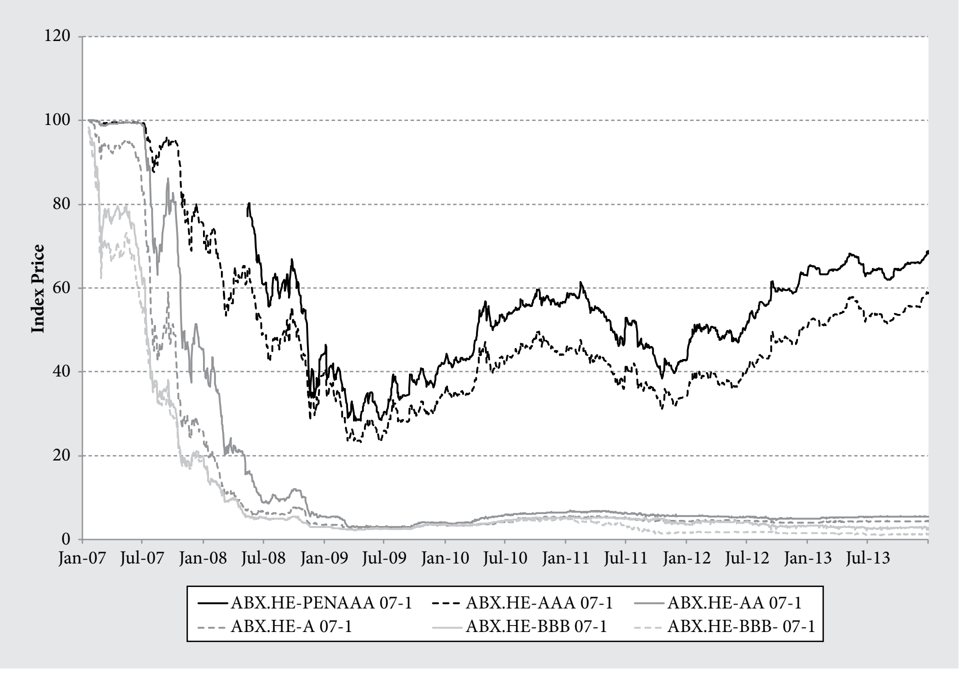


FIGURE 34.5 ABX sub-indices prices of 2007-1 vintage

Source: Markit

other sub-indices of the 07-1 vintage, although it followed a similar pattern. The AAA sub-index reached its minimum at the beginning of April 2009, fixing at 23.25, and after that it gradually started to recover, fixing at a price around 60 by December 2013.

Figure 34.6 shows the prices of the highest-rated sub-indices of the January 2006 and July 2007 vintages from January 2007 to December 2013.

Like the 07-1 vintage, the 06-1 and 07-2 vintages fell in summer 2007 and their prices continued decreasing through the beginning of 2009. As we can see from Figure 34.6, the 06-1 vintage of the ABX.HE AAA was less severely impaired than the 07-1 and 07-2 ones, with a maximum loss in value of slightly more than 40%. In addition, the ABX.HE AAA 07-2 vintage and the ABX.HE AA 06-1 performed similarly during and after the financial crisis. Sub-indices with AA rating or lower from the 07-2 vintage performed poorly and reached price levels below 10.

CMBX Indices

CMBX indices also declined during the financial crisis. As shown by Figure 34.7, the CMBX index Series 3 (April 2007 vintage) reported an increase in spread at the beginning of 2009.

As we saw for the ABX.HE index, the lowest-rated sub-indices were more severely affected by the crisis. The index spread of the CMBX BB Series 3 increased by more than 4,300 basis points between January 2009 and April 2009.

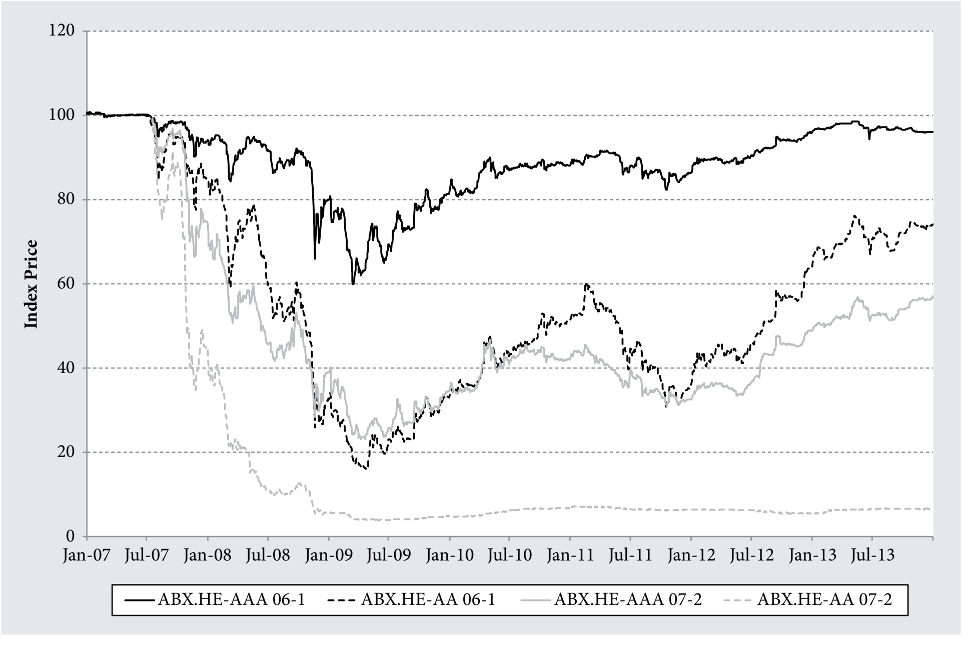


FIGURE 34.6 ABX prices for AAA and AA tranches of 2006-1 and 2007-2 vintages

Source: Markit

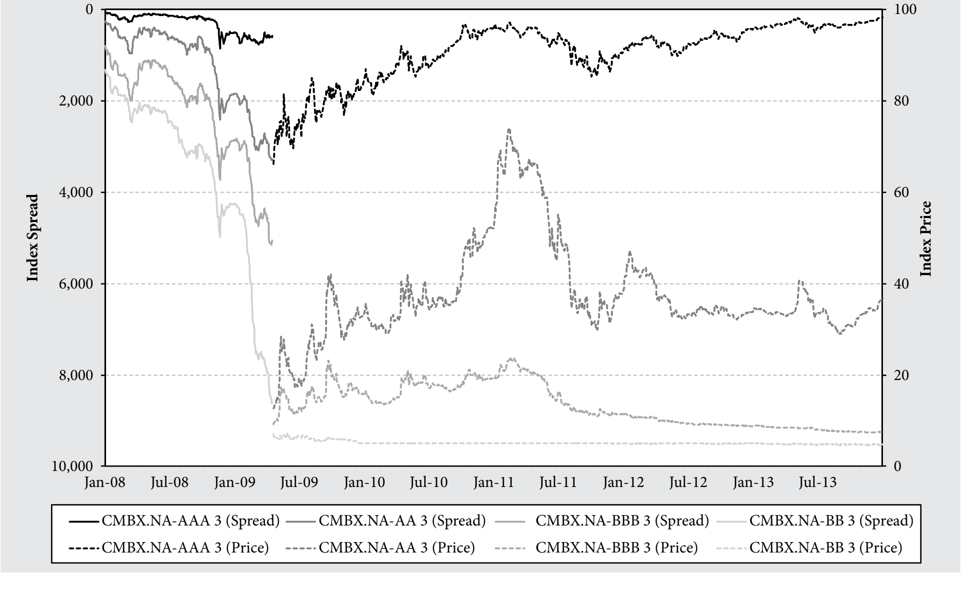


FIGURE 34.7 CMBX spreads and prices for AAA to BB tranches of Series 3

Note: CMBX indices began trading on price instead of spread starting from April 20, 2009. Annex date for Series 3 is April 2007.

Source: Markit

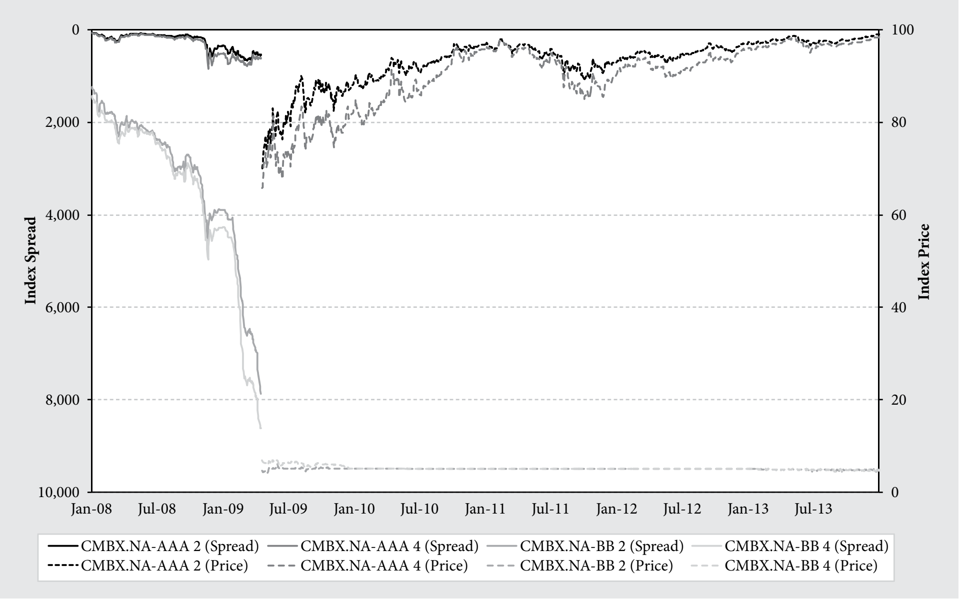


FIGURE 34.8 CMBX spreads and prices for AAA and BB tranches of Series 2 and Series 4

Note: CMBX indices began trading on price instead of spread starting from April 20, 2009. Annex date for Series 2 is October 2006, for Series 4 is October 2007.

Source: Markit

In April 2009, the CMBX indices began to be traded on price instead of spread levels. Around that time, aside from the lowest-rated sub-indices, the prices of the CMBX index Series 3 started to recover, as shown by Figure 34.7. For example, the price of the AAA sub-index recovered from a level of 66.27 as of April 20, 2009 to 95.99 as of December 31, 2010.

Similar conclusions can be drawn for other earlier and older vintages of the CMBX index, such as Series 2 (October 2006 vintage) and Series 4 (October 2007 vintage). Figure 34.8 shows the evolution of the highest- and lowest-rated sub-indices of the October 2006 and October 2007 vintages from January 2008 to December 2013.

Series 2 and Series 4 of the CMBX index followed a path similar to Series 3. Before April 2009, when the index was still trading in terms of spreads, the three different series for the highest-rated sub-index (AAA) moved closely together. After April 2009, Series 2 (the October 2006 vintage) started to diverge slightly and to trade at price levels higher than the other series.

PRIMEX Indices

As already discussed, the PRIMEX indices track the performance of the prime residential mortgage-backed securities market.

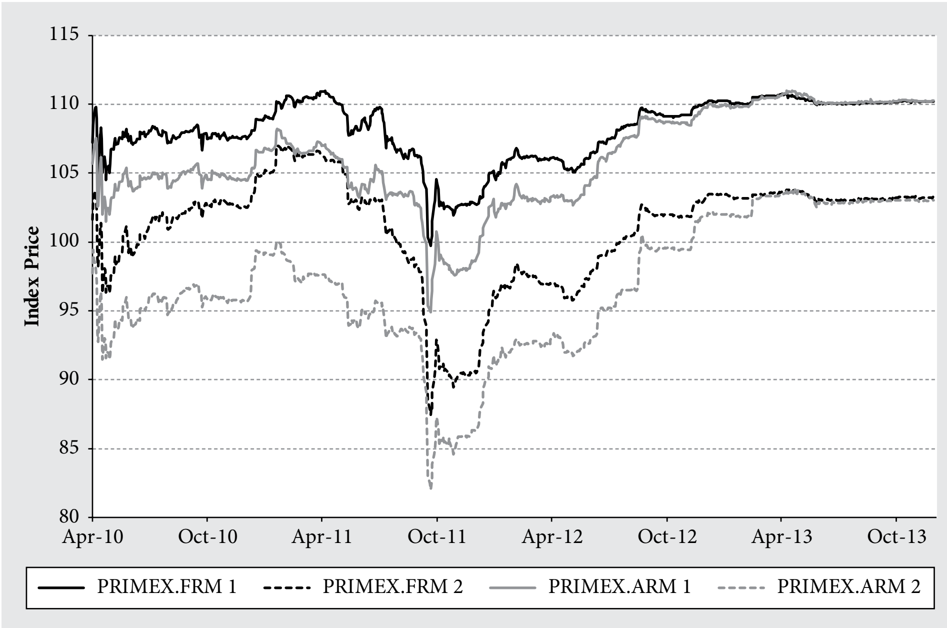


FIGURE 34.9 PRIMEX prices for FRM and ARM sub-indices of Series 1 and Series 2

Source: Markit

As shown in Figure 34.9, the prices of the PRIMEX sub-indices and series generally have followed similar patterns. However, similar to what we previously observed with regard to the subprime-related indices, earlier vintages of the PRIMEX sub-indices performed better than the more recent vintages. Specifically, Series 1 vintages, which track the performance of the loans issued between January 2005 and July 2006, have been traded at consistently higher prices than Series 2 vintages, which track the performance of the loans issued between July 2006 and December 2007. As an example, compared to the PRIMEX.ARM Series 1, the PRIMEX.ARM Series 2 decreased by an additional six percentage points from the date of the index inception through October 18, 2011, the day it reached its historical minimum.

Figure 34.9 also shows that until early 2013, PRIMEX.FRM index, which tracks the performance of securitized fixed-rate pools of mortgaged loans, generally performed better than the PRIMEX.ARM, which is linked to hybrid adjustable-rate loans.

Level of Credit Derivative Activity and Risk

The gross notional amounts reported by DTCC reflect the aggregate notional value of all contracts bought or sold. The net notional amounts represent the total amount of net protection bought on a specific reference entity across all counterparties.[24] Both measures, the gross and net notional, have dropped since 2008, indicating reductions in both the level of trading activity in the indices and in the net level of risk taken.

Figure 34.10 shows the evolution of net notional amounts for the ABX.HE index grouped by rating classes (AAA with Penultimate AAA, AA with A, BBB with BBB−) and split by vintage (06-1 with 06-2 and 07-1 with 07-2).

Overall, the net notional amounts of the ABX indices have been declining. The net notional amounts of higher-rated tranches for the 07-1 and 07-2 indices have generally been declining more than the 06-1 and 06-2 series of the same level of seniority. The prices of the two 2007 indices also declined more substantially than those of the two 2006 indices as well, suggesting that market participants were less interested in taking positions in indices where the underlying securities have performed relatively poorly.

Figure 34.11 shows evolution of gross notional amounts for the ABX.HE sub-indices grouped by rating classes (AAA with Penultimate AAA, AA with A, BBB with BBB−)

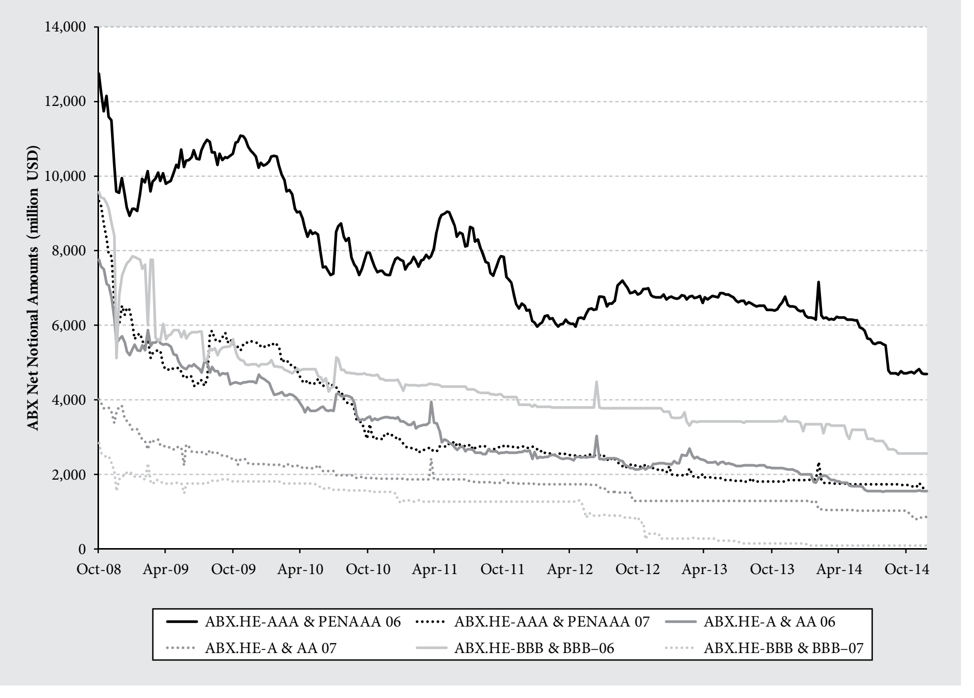


FIGURE 34.10 ABX net notional amounts

Source: Depository Trust & Clearing Corporation (DTCC)—Trade Information Warehouse Data

[24] For example, if Company A bought $10 million in protection on a credit from Company B and in turn Company B bought $10 million in protection on that same credit from Company C, then only Company A and C are exposed to the name in question. If these were the only trades referencing the credit, then DTCC would report $20 million in gross notional outstanding and $10 million in net notional.

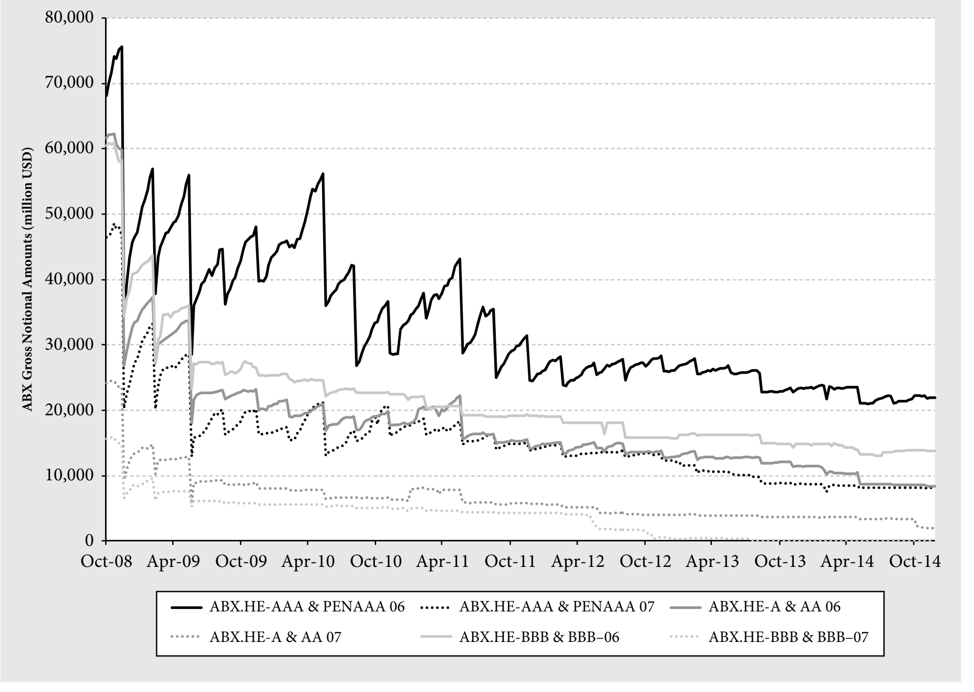


FIGURE 34.11 ABX gross notional amounts

Source: Depository Trust & Clearing Corporation (DTCC)—Trade Information Warehouse Data

and split by vintage (06-1 with 06-2 and 07-1 with 07-2) from October 2008 to December 2014.

The decline in the gross notionals outstanding in the ABX market has been somewhat greater than the decline in net notionals. For example, in the ABX.HE AAA and PEN AA 2006 sub-indices, the net notional amounts have declined by roughly 62%, whereas gross notional amounts have decreased by approximately 68%.

Evolution of Credit Mitigants and Counterparty Credit Risk Measurement in the CDS on MBS Markets

The credit crisis brought more attention to the presence of counterparty risk in a CDS trade. Counterparty risk refers to the risk that one of the two parties in a CDS trade may not be able to make their required payments. The missed payment could refer to either the regular fixed coupon paid by the protection buyer or the payment made upon a credit event by the protection seller.

To address counterparty risk, market participants are posting collateral more regularly. In addition, the computation of a *counterparty valuation adjustment* (CVA) to the market value of a firm's derivative holdings is becoming more common.

Collateral and Other Credit Mitigants

Credit mitigants are contractual measures designed to mitigate counterparty risk. Among commonly used credit mitigants are posting collateral or margin, contract downgrade provisions, and termination clauses.

Collateral requirements are contract agreements under which each counterparty is required, under certain conditions, to post collateral over the course of a financial contract. The posting of collateral reduces counterparty risk as, if there is a default or missed payment, the collateral can be seized by the non-defaulting party.

Collateral typically takes the form of cash or other liquid instruments. It is usually posted by a party to a trade when the mark-to-market value of their derivative position is negative. This computation can take place on a trade-by-trade basis, but is more often done on a net basis. For example, two counterparties will add up the mark-to-market value of all of their derivative positions, and then whichever counterparty has a negative mark-to-market value in total would be required to post collateral.

Although collateral was frequently posted before the financial crisis, its use became more common in the years following the crisis. Figure 34.12 shows that collateral usage increased after 2008.

For exchange-cleared instruments, instead of collateral being exchanged or posted by a counterparty, a *margin* amount is posted with the exchange (or clearing house), possibly

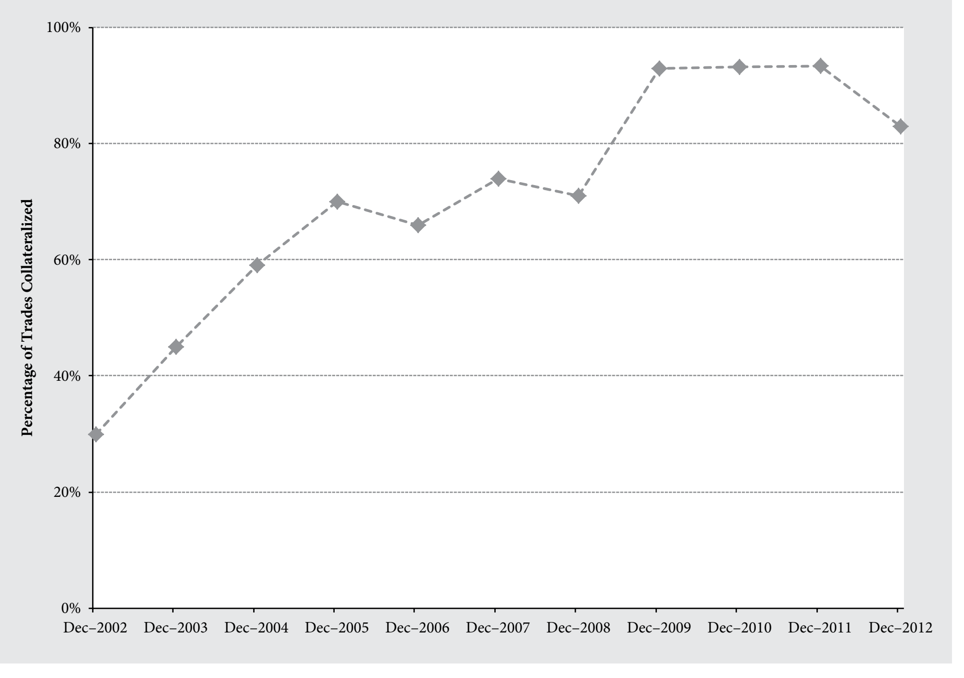


FIGURE 34.12 Percentage of credit derivative trades collateralized relative to trade volume

Source: Data from 2006–13 ISDA margin surveys, which provide data as of the end of December of the previous year. The 2006 survey provided data dated 2002–5. ISDA changed the survey methodology for data dated December 2010 and forward, noting that the results were "not strictly comparable" to previous years.

by both counterparties. Each of the clearing organizations has developed their own margin rules and requirements. Typically, the counterparties are required to post *initial margin* with a clearing body and then a *variation margin* is posted, depending on the change in market value of the instrument.[25] It has been argued that the use of exchanges and/or clearing houses will reduce the systemic risk in the financial system; however, their presence does introduce the possibility that they themselves may default.[26]

Downgrade provisions stipulate that a trade or portfolio of trades with a counterparty will be settled at the market value if the counterparty credit rating falls below a predetermined level.

Some of the individual trades in a portfolio of trades with a counterparty may be also subject to *termination clauses*. Such clauses postulate the termination of a trade if its market value falls to a certain level.

The use of collateral or other credit mitigants generally decreases the required capital and thus helps financial firms manage regulatory requirements better. For CDS, as will be discussed later, there has been a growing regulatory pressure to move from over-the-counter trading to central clearing.

CVA

There are a few ways to incorporate credit or default risk in valuing a derivative position. For example, one can discount the expected cash flows of the financial asset (e.g., MBS portfolio, CDS on MBS) using a discount rate that incorporates a credit risk adjustment, or one can apply the CVA. The latter approach has become more common in the industry, and has also entered the capital ratio and other calculations required by the regulatory bodies. In order to estimate a CVA, one first values an asset assuming no credit risk (i.e., no risk of default or credit deterioration), and then adds a specific monetary amount that compensates for the expected credit risk associated with owning such asset. The CVA takes into account the expected probability of default of a counterparty and the expected loss given default, as well as any existing contractual credit mitigants.

In recent years, and especially in the aftermath of the financial crisis, it has become increasingly important to evaluate the CVA in a consistent fashion. Specifically, the Basel Accords[27] require financial firms to develop an "IMM" or "internal models methodology" for the evaluation and internal validation of the capital requirements. The purpose of the IMM approach is to translate a derivative exposure (such as credit derivative exposure) into a comparable "effective loan notional," so regulators can compare different portfolios and instruments, and ultimately, capital ratios computed by different

[25] Factors such as trade size, liquidity, and the type of the instrument would play a role in determining the size of an initial margin.

[26] See, for example, Jeremy C. Kress, "Credit Default Swap Clearinghouses and Systemic Risk: Why Centralized Counterparties Must Have Access to Central Bank Liquidity," *Harvard Journal on Legislation* 48/1 (2011), 49–93.

[27] As discussed in the next section, the Basel Accords are an international set of rules and standards meant to govern large financial intermediaries such as banks.

financial firms. The effective IMM exposure determines the level of the capital required by regulators.

Evolution of Regulations and Regulatory Response to the Credit Crisis

In the aftermath of the financial crisis, there have been a number of regulatory efforts aimed at increasing overall financial markets' transparency as well as raising capital requirements for the credit derivatives and securitized products. The final sections discuss some of such recent efforts as well as the evolution of a few key regulations relevant to the participants of the credit derivatives markets for MBSs and CDOs.

Basel Accords

In 1974 the G10 countries established an international financial regulatory body, the Basel Committee on Banking Supervision. The Committee is comprised of the representatives from central banks and other regulatory authorities in a number of countries, including the US and most of the European nations. The Basel Committee does not have legislative or judicial authority; however, the participating nations are implicitly bound to implement and promote the Basel standards and recommendations.

A set of recommendations and "accords" known as *Basel 1* was introduced in 1988, with the purpose of promoting a set of "ground rules" for all "large, internationally active" banks and other financial intermediaries.[28] Basel 1 introduced the concept of *minimum capital requirements* for banks, which is meant to ensure that a bank has sufficient capital to operate and to promote overall financial system stability. To calculate the capital requirement, financial assets owned by a financial intermediary would be weighted by the "risk of counterparty failure" (i.e., their credit risk). For the purposes of the capital ratio calculations, Basel 1 put financial assets into a few groups such as cash holdings, investment securities, commercial loans, or residential real estate.

Following Basel 1, *Market Risk Amendment* was introduced in 1996. This amendment broadened the Basel Accords to cover market risk (i.e., the risk of losses arising from movements in market prices). For the first time, and assuming regulatory approval, banks were allowed to choose between two methodologies in their calculation of the capital ratios. These were a "standardized method" (such as formulaic credit risk weights in Basel 1) and "internal models method."[29] *Basel 2*, introduced in 2004,[30] further broadened the use of internal models and inputs in credit risk capital computations. In

[28] "International Convergence of Capital Measurement and Capital Standards," Bank for International Settlements, Basel (July 1988).

[29] "Amendment to the Capital Accord to Incorporate Market Risks," Bank for International Settlements, Basel (November 2005).

[30] Five large banks domiciled in the US adopted Basel 2 in 2005.

essence, this allowed banks to apply their internally developed models[31] to calculate the minimum capital requirements for a number of financial assets they held, including credit derivatives and mortgage-backed products.[32]

In 2009, in the aftermath of the financial crisis, *Basel* "2.5" was introduced as an emergency measure; around the same time, a *Basel 3* "Consultative Paper" was published.[33] Basel 2.5 significantly increased capital requirements for a number of financial assets held by banks, with particularly prominent increases for many correlation-based products such as CDOs. Basel 3 further increased capital requirements for a number of products and portfolios; it also introduced leverage constraints[34] as well as minimum liquidity and funding requirements.[35]

Further, Basel 3 introduced "CVA risk" (risk due to deterioration in counterparty's credit risk) as a separate type of risk that must be measured for the minimum capital ratios calculation. According to Basel 3, all securitized products have become subject to the "standardized charges" (i.e., instead of relying on internal models and internally provided inputs, banks now have to post a standard amount of capital per securitized product held). Such standard amounts (or regulatory "haircuts") are typically high,[36] and would likely result in further shrinkage of the securitization and ultimately related credit derivatives (CDSs on MBSs) markets.

Also, Basel 3 encouraged the move of OTC derivatives (including credit derivatives) to central clearing. In the US, such a move is further reinforced by the requirements of Title VII of the Dodd-Frank Act (enacted in 2010), which is further discussed in Chapter 4 ("New Regulations for Securitizations and Asset-Backed Securities").[37]

In May 2012, in an attempt to standardize a growing set of ad hoc adjustments and various capital add-ons introduced by Basel 2.5 and Basel 3, a "consultative document," "Fundamental Review of the Trading Book," was published by the Basel Committee.

[31] Or, in some cases, supply internally estimated inputs to the regulatory frameworks and models. Any bank that wished to adopt an internal model was incentivized to run the model in parallel with the standardized version (imposed by Basel 2 regulations) for at least a year to demonstrate the impact of the internal model on capital calculations. "International Convergence of Capital Measurement and Capital Standards: A Revised Framework," Bank for International Settlements, Basel (June 2004).

[32] Internal approaches were incentivized by requiring that banks increase their risk-weighted reserves if they used the "standardized approach."

[33] In 2013, the US adoption guidance was published. Basel 3 is set to "phase in" between 2014 and 2019.

[34] Notably, the Federal Reserve Board proposed a minimum leverage ratio of 5%–6% to take effect in 2018 (higher than the 3% level under Basel).

[35] "Enhancements to the Basel II Framework," Bank for International Settlements, Basel (July 2009); "Basel III: International Framework for Liquidity Risk Measurement, Standards and Monitoring," Bank for International Settlements, Basel (December 2010); "Basel III: A Global Regulatory Framework for More Resilient Banks and Banking Systems," Bank for International Settlements, Basel (June 2011).

[36] For example, the US Basel 3 assigns a risk weight of 1,250% to some of the securitized products, which means that capital charge may significantly exceed actual amount of exposure.

[37] In July 2013, the Federal Reserve Board, OCC, and FDIC approved the US Basel 3 final rule, implementing much of Basel 3 as well as changes that the Dodd-Frank Act required. It is considered the largest overhaul of banking capital standards in the US since the adoption of Basel 1.

This document is also commonly referred to as "*Basel 4*." Basel 4 further developed a notion of minimum liquidity requirements by introducing so-called "liquidity horizons," defined as "the time required to exit or hedge a risk position in a stressed market environment without materially affecting market prices."[38] In addition, Basel 4 requires capital add-ons for jumps in liquidity premiums. As many CDS on MBS positions are illiquid, such liquidity regulations are likely to have far-reaching effects on this market.

Dodd-Frank

The Dodd-Frank Act was signed into a law in the US in July 2010. It was introduced in the aftermath of the financial crisis, and meant to promote stability and transparency of the US financial system. Title VI ("Improvements to Regulation of Bank and Savings Association Holding Companies and Depository Institutions", also commonly referred to as the "Volcker Rule") and Title VII ("Wall Street Transparency and Accountability") are particularly relevant for the financial industry overall and securitization and credit derivatives markets in particular. These two titles are briefly introduced below. See Chapter 4 ("New Regulations for Securitizations and Asset-Backed Securities") for further discussion of the implications of the Dodd-Frank Act for the credit derivatives and securitization markets.

Dodd-Frank Title VI: Volcker Rule and its Impact on the Credit Markets

A portion of Title VI introduces a set of regulations widely known as the "Volcker Rule." This rule prohibits any "banking entity" from engaging in proprietary trading as well as sponsoring or investing in a traditional hedge fund or private equity fund ("covered funds") in any significant manner.[39] The prohibition of owning or sponsoring covered funds may affect a number of securitization vehicles and products. The prohibition of proprietary trading may have implications for the overall liquidity of the financial markets, including limiting the liquidity of credit derivatives, mortgage-backed securities, and CDSs on MBSs.

Dodd-Frank Title VII: Exchange Clearing of Swaps

Title VII, or the "Wall Street Transparency and Accountability Act," would give the SEC primary authority over security-based swap markets, including single-name CDSs. Also, this Title would give the CFTC primary authority over other types of swap markets, such as the market for CDSs on indices (including swaps referencing ABS indices discussed earlier).

[38] Basel Committee on Banking Supervision, "Fundamental Review of the Trading Book" (May 2012), 3. Banks' exposures would be assigned into five liquidity horizon categories, ranging from ten days to one year.

[39] Dodd-Frank Wall Street Reform and Consumer Protection Act, Pub. L. No.111–203, § 619, 124 Stat. 1376 (2010). "Covered funds" include traditional hedge funds and private equity funds as well as certain foreign funds and commodity pools.

In addition, Title VII would require certain swaps to be publicly reported and also exchange-traded or centrally cleared. The Title allows for some exceptions (such as certain nonstandard or large positions); however, it is expected that such positions will be subject to heightened collateral requirements and other credit mitigants (such as contract downgrade provisions and termination clauses). It is also expected that there will be a further expansion of the types of products (including a growing portion of the CDS market) that are required to be cleared with a central counterparty.

Key Points

- Credit derivatives on MBSs and CDOs can refer to single security or to a basket of securities.
- Usage of credit derivatives referencing MBSs and ABSs has declined since the credit crisis.
- CDS contracts for MBSs and CDOs need to be specialized.
- ABX and CMBX prices have recovered since the credit crisis.
- Synthetic CDOs can provide a flexible way to structure CDOs.
- The credit crisis provoked a wider adoption of collateral provisions by market participants.
- A number of the recent regulations, specifically some of the recent Basel regulations, may have impacted the willingness of at least some of the financial institutions to participate in the credit derivative market for MBSs and CDOs.

Acknowledgments

We would like to thank Joanne Jia, Davide Oneglia, and Sara Sperling for their invaluable research assistance.

CHAPTER 35

A FRAMEWORK FOR DETERMINING RELATIVE VALUE IN THE AGENCY MBS MARKET

MARK FONTANILLA

After reading this chapter you will understand:

- the concept of relative value analysis;
- the progression and essential components of a practical relative value framework for assessing agency MBS assets;
- the significance of identifying overall investment constraints upfront;
- the importance of selecting and prioritizing risk and reward metrics in order to enhance consistency in the relative value decision-making process;
- why making a baseline call on future interest rates, establishing reasonable interest rate change scenarios, and estimating the resulting prepayment responses are indispensable in identifying relative value between investment options;
- the thought process and considerations when finalizing a relative value determination.

Selecting assets within the agency MBS market, with its wide range of pool and structured options, is both art and science in balancing risk/reward characteristics. Relative value analysis is a prevailing but very suitable approach for determining whether the risk/reward proposition of an individual agency-MBS-related security looks rich, cheap, or at a fair value versus other agency MBS securities, as well as in comparison to typical benchmarks. In this chapter, we provide a practical framework for assessing relative value in agency MBS products, given their uniqueness among asset classes in the fixed-income world.

The Relative Value Framework

Relative value analysis for agency MBS investments is essentially a triangulation process. In fact, it is quite analogous to the typical home appraisal method used in the residential real estate market, whereby several reasonable asset comparisons with a sufficient amount of similar features are used to ascertain an opinion of value on the subject property, which is then compared to the selling price. Similarly, an agency MBS relative value framework incorporates available comparable assets ("comps") that include sector benchmarks such as agency MBS TBAs, rates products such US Treasuries or swaps, and any pool or structure variations in-between. The subject security is then compared to these "comps" across various risk/reward metrics to identify relative value among the options.

A first, and sometimes undervalued, step in an efficient relative value analysis framework is to highlight the essential parameters and/or constraints for asset inclusion within an investor's particular strategy. With over 975,000 agency MBS pools outstanding (as of July 2015), along with thousands of CMO tranches and derivative options as well, individual investor strategic guidelines, whether legally mandated or self-imposed, provide for a first-level binary valuation. An MBS-related security may have perceived relative value versus a benchmark, but if it does not fit within a particular strategy, or could fall out of that strategy given a realistic range of rate and prepayment scenarios, then it has little to no relative value for the investor.

Parametric Constraints

Some of the more typical parametric constraints are:

- *Duration/average life targets*: This may include hard maturity limits, liability matching ranges, or designated portfolio targets.
- *Minimum yield thresholds*: Yield targets may be in place based on rate/return benchmarks (e.g., reference index returns, LIBOR), funding costs, or marketed and/or internal return on equity (ROE) targets.
- *Product types*: Not all agency MBS sector investors can buy the full range of available products. There may even be limitations on how much of a specific agency's collateral may be owned.
- *Hedged/unhedged*: Different investors may or may not be able to hedge their assets, which changes the range of product options they can participate in.

Critical Risk/Reward Metrics

After establishing strategic parameters, the next step is to determine what comparative risk/reward metrics are to be considered and, most importantly, which variable(s) will carry the highest weight versus the others. Elsewhere in this handbook, the theory and development of the various risk/reward measures used in the agency MBS market are already covered and therefore beyond the scope of this discussion, so we will deal solely with the output and application of these measures for relative analysis decision making.

As stated earlier, relative value analysis takes into account the risk/reward proposition of an MBS-related investment and compares it to that of benchmarks and/or another agency MBS sector security. Some of the major objective and subjective comparison metrics often utilized can be divided into either risk or reward categorizations.

Risk Metrics

The risk metrics typically considered in the framework include:

- *Duration*: Interest rate price sensitivity as measured by duration can be either a model duration (modified, cash flow, or effective/option-adjusted duration) or market duration (empirical duration, hedging duration, or coupon curve duration).[1] For agency-MBS-related securities, the effective or option-adjusted duration takes into account possible variations in future rates and the associated change in prepayment speeds over time.
- *Convexity*: Convexity is another interest rate risk measure that estimates the rate of change in duration and is particularly applicable in projecting the possible effects of the short-option exposure investors have to underlying borrowers and their ability to refinance. Like duration, convexity can be calculated on a cash flow or option-adjusted basis.
- *Structural characteristics*: Differences in a security's rate calculation, term, principal, and/or interest flow, and other features either at the collateral or structural level provide for differences in risk exposure.
- *Market/trading characteristics*: Liquidity and bid/offer spreads may be a meaningful risk factor for investors that are sensitive to cash flow needs, total return valuations, or short-term trading profits.

Reward Metrics

The reward metrics commonly utilized in the framework include:

- *Yield*: A traditional income return measure that reflects the internal rate of return to maturity on projected cash flows for a given security price.
- *Spreads*: The spread measures used in the MBS market include:
  - o I Spread: The yield spread versus the weighted-average life point on the interpolated Treasury curve, given a single vector scenario, is commonly referred to as the I spread.

[1] See Chapter 31 for the alternative methods for computing duration for an MBS.

- o N Spread: The yield spread versus the weighted-average life point on the interpolated swap curve, given a single vector scenario, is commonly referred to as the N spread.
- o Zero-volatility spread: This is the cash flow spread, referred to as the Z spread, for a single vector scenario versus a reference spot rate curve.
- o Option-adjusted spread: This spread, referred to as OAS, is a model-dependent yield spread using multi-path scenarios versus a benchmark curve for discounting to a security price. OAS modeling takes into account the embedded options in agency MBS and the resulting estimate of changes in prepayments.[2]

- *Total return*: Rate of return over a specified time horizon that includes market value changes, coupon interest, and interest on coupon interest.

Critical Views

Once asset selection parameters are identified and the critical risk/reward metrics are established and prioritized, the next step in this framework is to formulate critical views in which the investor has to make a strategic call on certain key aspects of the future. For agency-MBS-related investments, which do not directly carry credit risk (which instead materializes itself through prepayment experience), the two most vital views to establish are first and foremost a rates view and subsequently a corresponding prepayment view. In particular, the view on interest rates should consider:

- *Directionality*: Whether interest rates overall are likely headed or biased higher, lower, or along current levels.
- *Magnitude*: For projected directional changes in interest rates, how large or small the changes may ultimately be. This also relates to the shape of the yield curve (e.g., flattening, steepening, etc.).
- *Timing*: Over what time period any magnitude changes are projected to occur.
- *Variability*: How much volatility in interest rate movements will there possibly be over the time period projection.

Scenarios

Perhaps the most critical part in determining relative value is not only looking at what would be the risk/reward proposition at a single baseline scenario, but perhaps more importantly, the variability of risks/returns within a range of scenarios for interest rates and corresponding prepayment speeds. After the investment parameters, risk/reward metrics, and rates/prepayment views are in place, this next step of scenario development can be formulated.

[2] The model used is the Monte Carlo simulation model for valuation, as explained in Chapters 24 and 31.

At a minimum, at least three scenarios should be incorporated in the relative value analysis of one security versus another:

- *Current view scenario*: This is a baseline scenario and reflects either what the investor thinks is most likely to happen or a middle-of-the-road projection.
- *At least one optimistic view scenario*: This scenario is more optimal for the returns of a specific security, and can be a simple, but favorable, parallel shift in the curve.
- *At least one pessimistic view scenario*: This scenario is a relatively worst-case scenario and is typically an opposite parallel curve shift to the more optimistic scenario.

These three minimum scenarios give the investor a relative value view across a better and worse scenario, centered around their "most likely" view. In addition, other views that incorporate different magnitudes of pessimism and optimism can be added to increase robustness of the scenario range analysis (note that proprietary and commercial prepayment/OAS models can run hundreds of Monte Carlo simulated, diverging paths), such as:

- *Static scenario*: A scenario that assumes no change in interest rates.
- *Zero return/break-even scenario*: A scenario that produces a yield or return of zero.
- *Worst-case scenario*: A scenario that reflects the investor's worst possible fear.

Once the interest rate outlook and valuation scenarios are outlined, the next views to set are the corresponding prepayment reactions to changes in rates. With the single most differentiating factor between discrete agency MBS securities being their unique sets of collateral and prepayment experience, an important part of the relative value assessment is to estimate what the respective speed differentials could be over time, given a range of rate scenarios. Relative value for agency MBS is a direct reflection of the prepayment variability and its effect on risk/reward profiles. Speed expectations based on interest rates and historic experience may be viewed differently if changes in mortgage and housing conditions warrant a divergence. Some of the considerations in a prepayment outlook include:

- *Baseline turnover*: Housing market activity can be influenced above and below expectations based on changes in economic conditions, geographics, and price trends. This is an important view to establish, especially in times of slow speeds and/or rising rates where the turnover component of prepayments becomes more of an influence.
- *Underwriting guidelines and pricing effects*: Changes in the stringency of mortgage guidelines can curb or enhance the prepayment response in any rate environment (e.g., HARP increased speeds on certain types of seasoned MBS collateral when it was introduced). In addition, the cost changes associated with various levels of underwriting can directly affect the amount of borrower incentive and influence

speeds (e.g., lowering of MIP costs for FHA borrowers in January 2015 subsequently increased certain GNMA speeds in the following months).

- *Burnout*: During periods of lower interest rates and higher borrower refinance incentives, the amount of time and incentive exposure that a borrower cohort is exposed to can create a dampening effect on remaining collateral balances.
- *Servicer behavior*: With the increasing amount of servicing transfer activity, different servicers have been shown to have a different servicing portfolio speed experience versus other servicers, even within the same types of loans with the same rates. This can be attributed to platform disparities, including different business models, cost structures, retention activities, and capacity.

The use of sophisticated proprietary and commercial prepayment models to provide speed and cash flow projections can be extremely valuable in order to have complex scenario and option-adjusted risk/reward measures calculated. Of course, every prepayment model will necessarily be different and therefore the outputs will be model-dependent. However, investors can also use empirical data to identify patterns and form expectations for future prepayment behavior in conjunction with, or independent of, the aforementioned prepayment models. The most useful empirical analysis types include:

- *S-curves or response curves*: This type of analysis takes a range of historical prepayment experiences for various borrower rates and plots the prepayment rate (usually 1-month CPR) across a range of borrower rate incentives, both positive and negative. This shows the change in prepayment speeds based on the magnitude of in-the-"moneyness."
- *Aging curves*: This type of analysis takes a range of historical prepayment experiences for a set of collateral and plots the prepayment rate (usually 1-month CPR) by loan age. This shows the pattern of prepayments over time as the collateral has aged.

Putting It All Together

The steps in this framework that have just been described lay the underpinnings for the final and most pivotal step of all: creating and analyzing outputs to discern relative value in the subject security or securities. To illustrate the thought process in this final step, we will use a theoretical example, with simple outputs, involving a hypothetical mortgage REIT investor with the following characteristics:

- A relatively conservative short-duration versus long-duration agency MBS strategy with a passive management approach.
- Focus is on net interest margins and preservation of dividend yield at approximately 10%, therefore has an aversion to relatively higher levels of mark-to-market and total return volatility.

- Vast majority of assets consist of whole agency MBS pools.
- Utilizes repo-financing of positions at an average of 1-month LIBOR + 50 basis points (which equated to a cost of about 70 basis points on 8/3/15), and keeps leverage targeted at an 8/1 ratio.

Assumptions

Given this theoretical investor and its basic portfolio strategy, we presume the following given the prevailing environment at the beginning of August 2015:

Investor Parameters/Constraints

The investor parameters and constraints are:

- Only agency MBS passthrough securities can be purchased. As such, we evaluate a generic new-issue FN 30-year 3.5%, a 15-year 3.0%, and a 7/1 2.875% hybrid ARM MBS security, as examples for comparison.
- Assets with target durations of around five years or less.
- Return threshold of about 1.95% (125 basis points over funding of 70 basis points levered eight times to meet the 10% dividend yield target).

Risk/Reward Metrics

With respect to risk/reward metrics, the selected variables and prioritization are as follows:

- *Yield*: Highest priority due to strategy of preserving net interest margin (NIM)/dividends and beating repo funding costs.
- *Modified duration/price risk*: Next highest priority due to a goal of return stability and duration target.
- *Yield/unit duration*: A blended risk/reward measure that gives an investor an indication of return per unit of price risk based on the two highest priority metrics for this particular investor.
- *Weighted-average loan rate (WALA)*: A secondary risk measure in this case that can further highlight shortening/extension and curve roll-down characteristics.
- *I Spread*: Similar to WALA, a secondary return measure in this case, to gauge yield spread over a comparable WALA point on the Treasury curve.

Critical Views

The critical views involve interest rates and prepayments. With respect to interest rates:

- *Direction*: Interest rates to stay range-bound, but rate risk is biased higher versus lower.
- *Magnitude*: If interest rates do rise, it would probably be in the +25 basis points range, but not likely more than +75 basis points in the medium term.

- *Timing*: Interest rate movements may develop over the next 6–12 months.
- *Variability*: Interest rate volatility to hover in +/−25 basis point trading range.

For the scenarios, the baseline case view is set at a +0 basis point shift in the curve (i.e. no change), but the range of scenarios incorporates the variability range of +/− 25 basis points and a bias for higher versus lower rates. As such, we use a wider range of upward parallel curve shifts versus a single lower parallel shift as outlined below and depicted in Figure 35.1:[3]

- +75 bp parallel shift (max medium-term view)
- +50 bp parallel shift
- +25 bp parallel shift (upper end of +/−25 bp variability view)
- +0 bp (baseline case view)
- −25 bp parallel shift *(lower end of +/−25 bp variability view)

As for prepayments, the view is that industry underwriting and risk-based pricing should remain stable. Prepayment responses should continue to be in line with the recent historical context.

The baseline principal profile curves, using prevailing market speed conventions and assumptions, and key themes for new issues will be as follows, and depicted in Figure 35.2:

- FN30 3.5% @ 175 PSA
- FN15 3.0% @ 200 PSA
- FN 7/1 2.875% @ 15 CPB (0–12-month ramp to 15 CPR)[4]

The key themes observed so far, with respect to baseline prepayment curves, are (1) the fixed-rate principal windows are significantly different among the three product types and (2) the principal payment "tails" are dramatically different, with the 30-year "tail" much longer and therefore principal cash flows are much more broadly distributed over the life of the security. On the shorter end of the spectrum, the 7/1 hybrid has relatively more principal cash flow front-loaded early in its life and back-ended at first reset. The 15-year is distributed somewhere in-between the two.

Using a select sample recent empirical prepayment experience by product cohort, we present and utilize the S-curves in Figure 35.3 as reference points for the estimated

[3] Note that for real-world practicality, rate shifts have a floor of zero.

[4] A hybrid ARM starts off like a fully amortizing fixed-rate mortgage during an initial fixed term, and then transforms into an adjustable-rate mortgage at first-rate reset for the remaining term. Effectively, the investor in a hybrid ARM MBS has what is akin to owning a short fixed-rate balloon with a future option on a forward-starting floater. At first reset, the investor has the option to either allow the investment to automatically convert into a floating-rate instrument, or sell it at the prevailing market value. In either case, pricing changes to a floater-convention-based discount margin (DM) over the hybrid ARM's reference index (usually LIBOR) and the rate risk shortens to simply the time left to the next rate reset (typically 12 months or less). The CPB prepayment speed convention assumes a balloon payment at first reset and allows for evaluation of the hybrid ARM MBS's fixed-rate component versus other types of fixed-rate MBS.

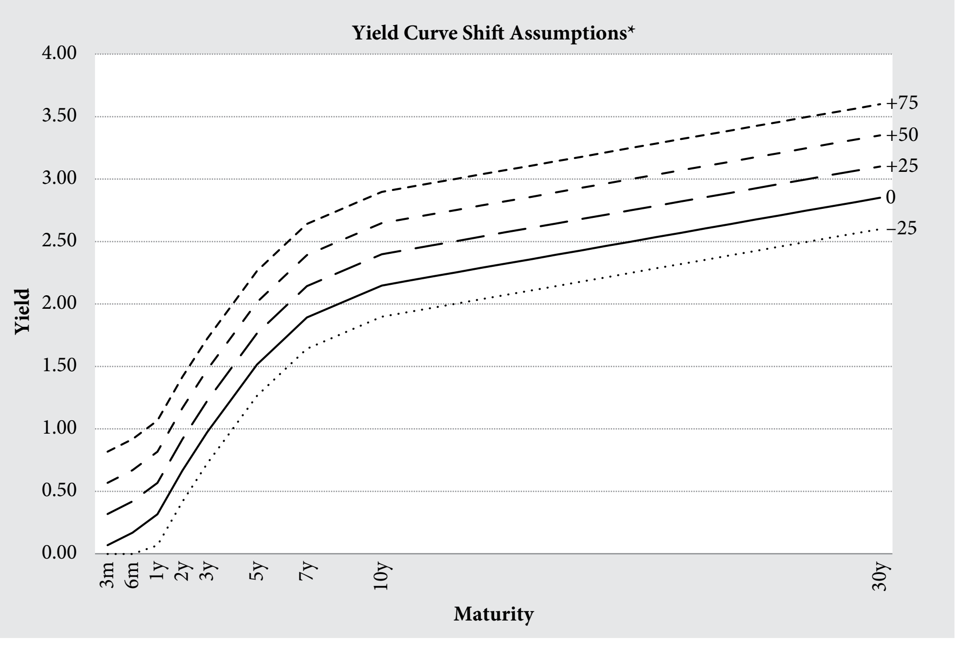


FIGURE 35.1 Yield curve shift scenarios based on interest rate views

Note: *Baseline yields for zero shift as of 8/3/2015

Source: CPR&CDR Alpha, LLC.

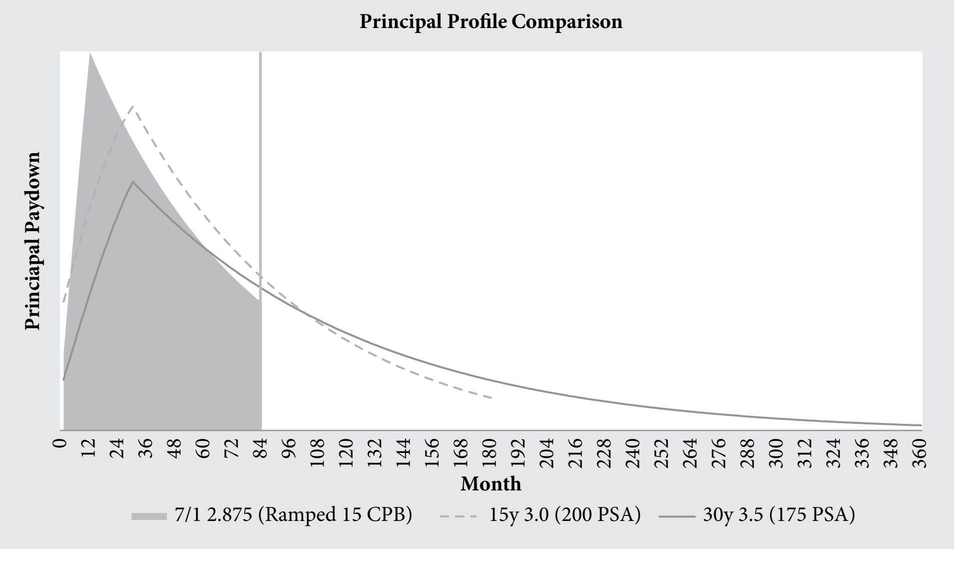
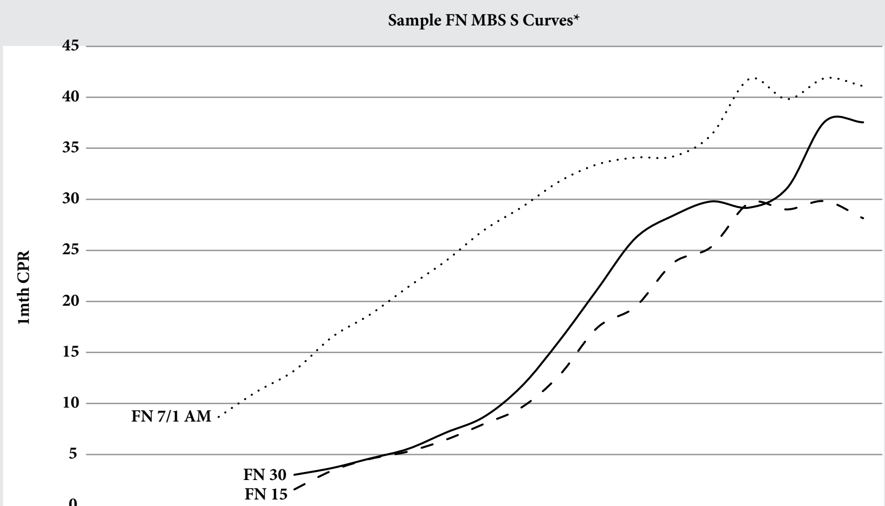


FIGURE 35.2 Example 30-year, 15-year, and 7/1 ARM MBS principal payment profiles

Source: CPR&CDR Alpha, LLC.

percent speed changes of each security given our prescribed rate shift scenarios. The key themes observed here are (1) the 30-year prepayment experience shows increasingly steeper speed increases as rates move through at-the-money to over 100 basis points in-the-money, highlighting that 30-year collateral has generally worse negative convexity characteristics versus shorter-term mortgage products and (2) the 15-year prepayment experience shows a relatively flatter, more subdued prepayment reaction to in-the-money scenarios versus the 30-year, while (3) the 7/1 hybrid ARM shows an even flatter, almost linear trajectory across a good portion of the S-curve versus the other products. This gives an insight into what the range of variability in cash flows and risk/return profiles should look like.



	−250	−225	−200	−175	−150	−125	−100	−75	−50	−25	0	25	50	75	100	125	150	175	200	225	250
FN 7/1 AM				8.7	11.1	13.2	16.5	18.7	21.4	24.0	27.0	29.2	31.8	33.4	34.1	34.2	36.3	41.8	39.8	41.9	41.1
FN 15						1.6	3.4	4.6	5.3	6.5	8.0	9.6	12.8	17.5	19.5	23.8	25.3	29.6	29.0	29.8	28.1
FN 30						3.0	3.7	4.6	5.5	7.1	8.7	11.7	16.2	21.2	26.2	28.4	29.8	29.2	31.1	37.6	37.5

Incentive vs. Mortgage Rate (bps)

* Observations from1/2012–7/2015 for 12–84 WALA collateral only. FN30 and FN 7/1 incentive vs. 30y mtge rate, FN15 vs. 15y mtge rate.

FIGURE 35.3 Sample 30-year, 15-year, and 7/1 ARM MBS empirical incentive-based S-curves

Source: CPR&CDR Alpha, LLC.

Outputs and Relative Value Analysis

Using August 3, 2015 (first business day of month) for our example analysis, we start with the base case risk/reward metrics given the prevailing price and interest rates, as shown in Table 35.1.

Table 35.1 Example base case risk/reward metrics

	FNCL 30y 3.50%	FNCI 15y 3.00%	FN 7/1 ARM 2.875%
Est. Price	$103-28	$103-28	$103-12
WAC	4.00	3.50	3.375
WAM/Window	360 mths	180 mths	360 (84) mths*
Speed Assumption	175 PSA	200 PSA	15 CBP (ramp)*
Wtd-Avg Life (Yrs)	8.1	5.4	4.4
Mod Duration (Yrs)	6.7	4.9	4.1
I-Spread (bps)	92	60	67
Yield	2.91%	2.19%	2.02%
Yield/Unit of Duration	0.43%	0.45%	0.50%

Note: Estimates for new issues as of August 3, 2015 trade/settle date

* 84-month fixed window modeled with 0–15 CPB over first 12 months

Source: CPR&CDR Alpha, LLC

In considering the particular investor profile and strategy for our example, key comparison observations and relative value determinations in the base case are:

- The price premiums are reasonably similar for these newly issued product/coupon types, with all three securities having $103 dollar handles, mitigating some of the premium risk differential among the security types.
- Using the 30-year as reference, the 15-year WALA is about one third shorter, while the 7/1 WALA is almost half as long.
- Using the 30-year again as reference, the 15-year duration is about 25% shorter, while the 7/1 WALA is about 40% shorter.
- On a theoretical risk/reward basis, the baseline yield per unit of duration on the 7/1 ARM is the highest at 50 basis points versus 43 basis points and 45 basis points for the 30-year and 15-year, respectively. This indicates a mild diminishing returns condition for extending out on the yield curve.
- All three securities in the base case exceed the yield target of 1.95%. While the 30-year is a markedly longer and higher-risk security relative to the 15-year and 7/1 ARM, it does pick up 25–32 basis points in I-spread and 72–89 basis points in yield relative to the other two products.
- Since the baseline duration of the 30-year is 6.7 years, over 30% longer than the prescribed maximum target duration of about five years, this eliminates the

30-year as a relative value choice in this instance. The 15-year and 7/1 are both within the target duration range.

- While both the 15-year and 7/1 ARM look suitable from a duration and yield target standpoint, the 15-year yields 17 basis points more than the 7/1. However, the 7/1 picks 7 basis points in I-spread, has 84% of the duration of the 15-year, and garners 50 basis points in yield per unit duration versus 45 basis points for the 15-year.
- From a prioritization and risk/reward standpoint, the 7/1 ARM has relative value over the 15-year and 30-year MBS options in the investor's base case scenario.

From the baseline case, we now look at critical scenario analysis where we can see the relative sensitivity of each security's risk/reward proposition. From our predetermined curve shift scenarios, we estimated speed changes for each scenario utilizing the previously calculated empirical product S-curves. Product baseline prepayment curves were adjusted faster or slower based on the approximate percentage speed changes, given the change in in-the-"moneyness" for each rate shift scenario (assuming the reference mortgage rate moved in tandem with the curve shift).

Table 35.2 shows the estimated variability in risk/reward metrics for our three security options across each curve shift scenario (assuming an instantaneous change for simplicity), including an estimated price change given a constant I-spread assumption.

Table 35.2 Estimated risk/reward metric changes grouped by MBS type

		Curve/Mtge Rate Shift (Instant)				
		−25	0	+25	+50	+75
FNCL 30y 3.50%	Speed Assumption	236	175	144	112	93
	Wtd-Avg Life (Yrs)	6.7	8.1	9.1	10.3	11.2
	Mod Duration (Yrs)	5.7	6.7	7.4	8.2	8.7
	Est. Px Change %	1.74%	0.00%	−2.07%	−4.42%	−6.68%
	Yield	2.81%	2.91%	2.97%	3.02%	3.06%
	Yield/Unit of Duration	0.49%	0.43%	0.40%	0.37%	0.35%
FNCI 15y 3.00%	Speed Assumption	241	200	161	132	114
	Wtd-Avg Life (Yrs)	5.0	5.4	5.8	6.1	6.4
	Mod Duration (Yrs)	4.6	4.9	5.2	5.5	5.7
	Est. Px Change %	1.19%	0.00%	−1.44%	−2.97%	−4.51%
	Yield	2.13%	2.19%	2.24%	2.28%	2.30%
	Yield/Unit of Duration	0.47%	0.45%	0.43%	0.42%	0.41%
FN 7/1 ARM 2.875%	Speed Assumption	114	100	88	71	60
	Wtd-Avg Life (Yrs)	4.1	4.4	4.6	4.9	5.1
	Mod Duration (Yrs)	3.9	4.1	4.2	4.5	4.7
	Est. Px Change %	1.09%	0.00%	−1.15%	−2.46%	−3.74%
	Yield	1.98%	2.02%	2.06%	2.11%	2.14%
	Yield/Unit of Duration	0.51%	0.50%	0.49%	0.47%	0.46%

Note: Estimates for new issues as of 8/3/2015 trade/settle date and constant I-spread pricing
Source: CPR&CDR Alpha, LLC.

For a more useful perspective, we rearrange the data by each risk/reward variable in order to do a relative value comparison between securities in Table 35.3. Additionally, we further segment the outputs by dispersion for rally, sell-off, and total range scenarios in Table 35.4.

Over the prescribed curve shift scenarios, we see the following key comparison observations and relative value determinations for this particular example of investor strategy:

- The longer-duration 30-year and its wider speed variability exhibit the most relative dispersion across risk/reward metrics, while the 7/1 ARM shows the least. In each up and down rate scenario calculated, the 30-year remains well above the five-year duration threshold, so the relative value for the theoretical investor here remains with either the 15-year or the 7/1 hybrid ARM.
    - The WALA and duration range of the 15-year and 7/1 hybrid ARM are closely distributed, but the 7/1 holds a modest edge. The 15-year does go above the five-year duration target in rate rise scenarios, although not by more than 15% in the +75 scenario, while the 7/1 stays within the five-year duration target in every

Table 35.3 Estimated risk/reward metric changes grouped by variable

		Curve/Mtge Rate Shift (Instant)				
		−25	0	+25	+50	+75
Speed Assumption	FNCL 30y	236	175	144	112	93
	FNCI 15y	241	200	161	132	114
	FN 7/1 ARM	114	100	88	71	60
Wtd-Avg Life (Yrs)	FNCL 30y	6.7	8.1	9.1	10.3	11.2
	FNCI 15y	5.0	5.4	5.8	6.1	6.4
	FN 7/1 ARM	4.1	4.4	4.6	4.9	5.1
Mod Duration (Yrs)	FNCL 30y	5.7	6.7	7.4	8.2	8.7
	FNCI 15y	4.6	4.9	5.2	5.5	5.7
	FN 7/1 ARM	3.9	4.1	4.2	4.5	4.7
Est. Px Change %	FNCL 30y	1.74%	0.00%	−2.07%	−4.42%	−6.68%
	FNCI 15y	1.19%	0.00%	−1.44%	−2.97%	−4.51%
	FN 7/1 ARM	1.09%	0.00%	−1.15%	−2.46%	−3.74%
Yield	FNCL 30y	2.81%	2.91%	2.97%	3.02%	3.06%
	FNCI 15y	2.13%	2.19%	2.24%	2.28%	2.30%
	FN 7/1 ARM	1.98%	2.02%	2.06%	2.11%	2.14%
Yield/Unit of Duration	FNCL 30y	0.49%	0.43%	0.40%	0.37%	0.35%
	FNCI 15y	0.47%	0.45%	0.43%	0.42%	0.41%
	FN 7/1 ARM	0.51%	0.50%	0.49%	0.47%	0.46%

Note: Estimates for new issues as of 8/3/2015 trade/settle date and constant I-spread pricing

Source: CPR&CDR Alpha, LLC.

Table 35.4 Estimated risk/reward metric changes dispersion

		Scenario Dispersion			
		Rally Range	0	Sell-Off Range	Total Range
Speed Assumption	**FNCL 30y**	61	175	−82	143
	FNCI 15y	41	200	−86	127
	FN 7/1 ARM	14	100	−40	55
Wtd-Avg Life (Yrs)	**FNCL 30y**	−1.4	8.1	3.1	4.5
	FNCI 15y	−0.4	5.4	1.0	1.4
	FN 7/1 ARM	−0.3	4.4	0.7	1.0
Mod Duration (Yrs)	**FNCL 30y**	−1.0	6.7	2.0	3.0
	FNCI 15y	−0.3	4.9	0.8	1.1
	FN 7/1 ARM	−0.2	4.1	0.6	0.8
Est. Px Change %	**FNCL 30y**	1.74%	0.00%	−6.68%	8.42%
	FNCI 15y	1.19%	0.00%	−4.51%	5.70%
	FN 7/1 ARM	1.09%	0.00%	−3.74%	4.84%
Yield	**FNCL 30y**	−0.10%	2.91%	0.15%	0.25%
	FNCI 15y	−0.06%	2.19%	0.11%	0.17%
	FN 7/1 ARM	−0.05%	2.02%	0.12%	0.16%
Yield/Unit of Duration	**FNCL 30y**	0.06%	0.43%	−0.08%	0.14%
	FNCI 15y	0.02%	0.45%	−0.04%	0.06%
	FN 7/1 ARM	0.01%	0.50%	−0.04%	0.05%

Note: Estimates for new issues as of 8/3/2015 trade/settle date and constant I-spread pricing
Source: CPR&CDR Alpha, LLC.

scenario. Over the total range of scenarios calculated: (1) 1.4-year WALA/1.1-year duration variation range for the 15-year and (2) 1.0-year WALA/0.8-year duration variation range for the 7/1.

- The estimated price change across curve shifts also gives a stability advantage for the 7/1 over the 15-year as well. The 15-year performs marginally better in the −25 basis points rally scenario, with an estimated price appreciation of +1.19% versus 1.09% for the 7/1, or an 8% price appreciation advantage for the 15-year. On the other hand, in the multiple sell-off scenarios, the price depreciation of the 7/1 is relatively less by an increasingly greater percentage as rates move higher. The price loss for the 15-year is over 20% greater versus the 7/1 in the rate rise scenarios. Given that the investor's rate risk view is biased higher, this gives a clear relative value edge to the 7/1.
- Both yield and yield/unit duration hold relatively steady across lower and higher rates, staying within just a few basis points between the two products, so the return variability is very similar for the 15-year and 7/1.
- While the 15-year does pick 17 basis points versus the 7/1 in the base case, or almost 5% higher, the 7/1 does have about 10% or more yield/unit duration over every calculated scenario, providing a risk/reward advantage.

In sum, for our example investor, the 7/1 hybrid ARM has more appealing relative value versus either the 30-year or 15-year options based on:

- A better relative risk/reward profile for the 7/1 with respect to its yield-per-unit duration, given the view that rate risk is deemed to be biased toward higher rates versus lower rates.
  - There is either a better or similar yield variability across lower and higher interest rates, but less price variation across lower, and particularly higher, interest rate scenarios which provides for a better total return profile for the 7/1 to preserve margins and return targets.
  - The 7/1 duration stays within target range in each calculated interest rate shift.

Alternatively, the relative value determination for a different type of investor may not favor the 7/1 hybrid ARM option over the 30-year and 15-year fixed-rate options from our example outputs. For instance, if the investor has a more active investment strategy, such as a hedge fund that relies on short-term trading gains or a money manager that targets total return outperformance versus a tracking index, the risk tolerance may be higher and return maximization more important. In these instances, the higher projected yield/carry, better liquidity, and much larger available float of the 30-year or 15-year MBS options may provide greater relative value than the less-produced, lower-yielding 7/1 hybrid ARM option, despite its relatively lower curve and prepayment risk.

The practical framework presented here for assessing relative value in agency MBS allows for flexibility to suit different investor goals and strategies. As described, the framework incorporates a methodical sequence, but allows for various different risk/reward metrics to be added, subtracted, and prioritized as appropriate for the circumstance. Further, scenarios can be implemented in numerous configurations to determine whether a particular agency MBS investment security has relative value versus other agency MBS securities, which is highly useful given the uniqueness of agency MBS product cash flows versus typical bullet maturity fixed-income products.

Key Points

- A practical relative value framework is particularly appropriate for analyzing agency MBS, given the variability in risk/reward outcomes for changes in interest rates.
- The determination of relative value is based on perspective; for the same MBS investment options, different investors may have different valuation protocols and therefore different opinions of relative richness or cheapness between securities.
- A practical relative value framework is a way to make the asset selection process more efficient and to convert an investor's particular perspective into a more systematic decision-making approach.
- Vital to the relative value process is investor establishment of a baseline view for future interest rates, reasonably optimistic and pessimistic variations of this baseline view, and the corresponding effect on prepayment speeds.

- The prioritization of risk/reward metrics, from highest to lowest importance, helps establish a more concise and objective relative value framework.
- The major risk metrics utilized for agency MBS relative value analysis are various types of duration and convexity measures, while primary reward metrics considered are yield, spread, and total return measures.
- The risk/reward outcomes of any agency MBS investment alternative is a direct reflection of its particular prepayment profile.
- For agency MBS investments, neither a single risk/reward variable nor a single rate scenario is necessarily enough to assess relative value. It is the analysis of a combination of numerous risk/reward metrics across multiple rate and speed scenarios that provides a robust range of relative value triangulation points. Therefore, scenario analysis and the dispersion of risk/reward outcomes is an essential step in the relative value process.

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