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Introduction

The US mortgage-backed security (MBS) market is the largest sector of the US fixed rate investment-grade bond market, comprising over $3.4 trillion outstanding as of 2006, more than a third of US investment-grade bond indices. The investor base has broadened significantly over the past few years allowing the market to grow over 8% in 2006. MBS also have a strong influence on other areas such as swaps and options. While this paper covers introductory topics, it also contains advanced material on relative value analysis, prepayments, and hedging. Note that we cover primarily fixed-rate MBS in this guide. If you are unfamiliar with the product, it would be helpful to read the Glossary in the Appendix before reading the paper.

Chapter 1: The Basics

Why Does the MBS Market Exist?

The MBS market was started in 1970 with the issue of the first GNMA pass-through security. This security bundled mortgage loans together and passed through the principal and interest to the investor. Before this time, mortgages traded only in “whole loan” form, where the investor was subject to credit risk. The agency MBS market initially removed the credit risk for investors by guaranteeing timely payment of principal and interest, placed the mortgages in a more liquid form, and allowed for continued improvements in price transparency over time. From the government perspective, securitizing mortgages added capacity to the mortgage lending system, facilitating a fall in mortgage rates over time and a rise in homeownership.

Background on the agency Mortgage Market

The fixed rate agency mortgage-backed security (MBS) market totals $3.4 trillion at the time of this writing. The issuers are FNMA, FHLMC and GNMA. We will cover their specific roles in detail later in this paper. Figure 1 shows outstanding residential fixed-rate MBS balance for each entity, with FNMA being the largest.

<table>
<thead>
<tr>
<th>Entity</th>
<th>Outstanding Balance (billions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fannie Mae</td>
<td>$2,022</td>
</tr>
<tr>
<td>Freddie Mac</td>
<td>$1,462</td>
</tr>
<tr>
<td>Ginnie Mae</td>
<td>$413</td>
</tr>
<tr>
<td>Non-agency</td>
<td>$1,834</td>
</tr>
</tbody>
</table>

Figure 1: Outstanding fixed rate MBS as of December 31, 2006 (billions)

Agency pass-throughs are comparable to the US Treasury\(^1\) market in terms of liquidity and significantly better than US corporate bonds. The most liquid pass-throughs have bid-ask spreads of approximately 1/64\(^{th}\). Over $250 billion of mortgage bonds trades hands every day. Figure 2 shows mortgage trades reported to the Federal Reserve by primary dealers, which account for approximately 90% of all MBS trades.

\(^1\) Often abbreviated UST in this paper going forward.
We summarize the benefits of US MBS to investors:

- **Attractive Yields.** Spreads over UST are typically 60 to 200 bp, depending on the exact security and the current market environment.

- **Price Transparency.** Prices are quoted live to the nearest 1/64th by many market sources, including Bloomberg and TradeWeb.

- **High Credit Quality.** GNMA securities are full faith and credit of the US government. FNMA and FHLMC securities are rated AAA. Currently BIS risk weight for banks are 20% for FNMA and FHLMC and 0% for GNMA.

- **Short Durations.** Despite long maturities, prepayment makes the duration and spread duration of MBS relatively short, typically 3 to 4 years OAD.

- **High Liquidity.** Few bonds other than US Treasuries have better liquidity than US MBS.

### Mortgage Characteristics

Most mortgages securitized in the agency pass-through market have the following characteristics:

- Mortgages are generally of 15-year and 30-year maturities, fully amortizing. “IO” loans which do not start amortizing for typically 10 or 15 years are also popular. Limited amounts of 10-year, 20-year, 40 year and balloon (short maturity, not fully amortizing) mortgages are securitized as well.

- Mortgages must be on a 1–4 family home. The maximum loan balance for a single family home is updated each year. For 2006, the maximum balance is $417,000, which covers roughly 80% of the homes in the US.

- Fixed and adjustable rate mortgages are securitized in separate programs. The ARMs market mainly consists of “hybrid ARMs” where the rate is fixed for 3, 5, 7, or 10 years before it starts adjusting. MBS included in the large U.S. bond indices are all fixed-rate.

- The vast majority of mortgages backing FNMA and FHLMC pools are not assumable, meaning the mortgagor must pay off the loan upon sale of the residence (due on sale). Note that FHA mortgages backing GNMA loans are assumable, reducing prepayment speeds there in a period of high interest rates and low home price appreciation.

- Mortgages are virtually all monthly-pay, in arrears.

- Almost all U.S. mortgagors in agency pools may pay off all or a portion of their principal balance at any time without a prepayment penalty. Prepayments increase when mortgage rates fall and homeowners refinance.

---

2 There are programs from GNMA and the GSEs for multifamily mortgages, but they are completely separate from the single-family mortgage market discussed in this paper.
existing loans into new loans to receive a lower interest rate or take equity out of the property. Mortgage loans with prepayment penalties securitized by the agencies make up less than 1% of outstanding securities, and pools of prepay penalty loans are not eligible for TBA delivery.

**GNMA and the GSEs**

GNMA and the Government Sponsored Enterprises (GSEs) involved in the US housing market provide several functions, some of which are in a state of flux because of their regulator, the Office for Federal Housing Enterprise and Oversight (OFHEO).

- They pool mortgages together into pass-through securities for investors.
- They guarantee the investor timely payment of interest and principal on these pass-throughs.
- They help standardize issues for secondary market trading in conjunction with the Securities Industry and Financial Markets Association (SIFMA), an industry trade group that sets TBA and other MBS guidelines.
- They also issue REMICs backed by these loans.
- The GSEs purchase mortgage loans or securities. In addition to potentially making profits for the GSEs, this action supports the secondary mortgage market and keeps primary mortgage rates low for homeowners. This activity is currently under review by OFHEO, and growth of so-called “retained” mortgage portfolios is currently limited. GNMA currently does not buy loans or pass-throughs except for those acquired because of loan defaults.
- The GSEs also have a “housing mission” supervised by the Department of Housing and Urban Development (HUD) to increase homeownership generally and specifically in disadvantaged areas.

**Ginnie Mae**

Ginnie Mae (GNMA) was created from an existing entity in 1968 as a wholly owned corporation within the Department of Housing and Urban Development (HUD). Its purpose is to serve low to moderate income homebuyers, primarily by offering low downpayment loans. Ginnie Mae primarily securitizes Federal Housing Administration (FHA) and Veterans Administration (VA) loans into pass-throughs and those pass-throughs into REMICs. Congress controls the maximum loan size of mortgages securitized, currently 85% of the FNMA and FHLMC conforming loan limit, up to $354,450 in high cost areas for FHA, but $417,000 for VA. Note that there is currently a bill in place that could increase the maximum loan size to 100% of the conforming loan limit. The underlying loans have partial government guarantees (e.g. FHA whole loans are already 99% government guaranteed) and GNMA pass-throughs and REMICs have the full faith and credit of the US government. Ginnie Mae’s excess revenue (mostly from homeowner insurance fees) is placed in an insurance fund, which is wholly invested in non-marketable US Treasury securities. Ginnie Mae has a small loan portfolio, primarily consisting of loans acquired from defaulted servicers or other unusual situations.

**Fannie Mae**

Fannie Mae (FNMA) is the private counterpart to Ginnie Mae, created in 1968 when the government split the original Ginnie Mae into public and private pieces. Fannie Mae primarily securitizes non-government-guaranteed mortgages, although they are allowed to securitized FHA/VA loans as well. Congress limits the maximum loan size of mortgages securitized by Fannie Mae and Freddie Mac, known as the conforming loan balance, currently to $417,000 for 2006. The conforming loan limit is increased by home price inflation each year as designated by OFHEO. Fannie Mae has a large retained mortgage portfolio, which consists of agency MBS and whole loans (unsecuritized loans, and includes ARMs as well as fixed-rate MBS.

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3 Many market participants collectively refer to the GSEs as “agencies.” Technically, Fannie Mae and Freddie Mac are no longer agencies of the US government, but private corporations. However, each still has a $6.25 billion credit line at the Treasury in case of emergency, and the President of the United States still has the privilege of appointing some board members for each organization. Ginnie Mae is still truly a government agency under the auspices of the Secretary of Housing and Urban Development. Hence, GNMA securities carry the full faith and credit of the US government.

4 Ginnie Mae website.
**Freddie Mac**

Freddie Mac (FHLMC) highly resembles their sister organization, Fannie Mae. Freddie Mac was created in 1970 and set a clear mission: stabilize the nation’s mortgage markets and expand opportunities for homeownership and affordable rental housing. Similar to Fannie Mae, they primarily securitize conventional, conforming loans and also have a retained portfolio with ARMs and fixed-rate MBS, as well as HEL and some multifamily security investments.

FHLMC and FNMA pass-through securities are collectively known as conventionals.

**Others — FHLB, Farm Credit Banks**

The Federal Home Loan Bank system makes “advances” (loans) to its member banks and thrifts and borrows money at agency rates. Each of the 12 individual banks is owned by its members, and the senior debt they issue is jointly and severally guaranteed by all of the banks together. They invest in mortgage loans and MBS with capital paid in by their members.

The FHLBs compete with Fannie Mae and Freddie Mac via the FHLB mortgage participation finance (MPF) and other similar programs (MPP). Unlike FNMA and FHLMC pass-through programs, the loans have not been securitized and the agency takes some, but not all of the credit risk on the pool of loans. The member/originator keeps some of the credit risk and needs to reserve capital against that risk.

The Farm Credit Banks have portfolios that contain mortgages. FHLB and Farm Credit debt issuance is typically exempt from state income tax, an advantage versus Fannie Mae and Freddie Mac debt that is currently state and federally taxable. FNMA and FHLMC mortgage pass-through securities are state and federally taxable to the investor. The FHLB has considered securitizing the MPF program, but that appears unlikely any time soon.

**Agency Mortgages**

Most of the trading in securitized US mortgages is via agency pass-throughs. Mortgage servicers collect principal and interest payments from loans they service and forward the money to the GSEs. The GSEs in turn forward payments to investors via the trustee. Note that each step in the process involves a delay in days for receipt of cash to the investor, as noted in the figure below.

![Figure 3: Agency pass-through characteristics](image)

<table>
<thead>
<tr>
<th>Agency/Program</th>
<th>Timely Principal and Interest Guarantee</th>
<th>Stated Delay Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>GNMA I</td>
<td>Full faith and credit of the US government</td>
<td>45</td>
</tr>
<tr>
<td>GNMA II</td>
<td>Full faith and credit of the US government</td>
<td>50</td>
</tr>
<tr>
<td>FNMA</td>
<td>FNMA guarantee</td>
<td>55</td>
</tr>
<tr>
<td>FHLMC Gold</td>
<td>FHLMC guarantee</td>
<td>45</td>
</tr>
</tbody>
</table>

1 The GNMA I program is large and more liquid. GNMA also has a smaller GNMA II program that includes adjustable rate mortgages. The GNMA II program has variable servicing fees.

**Mortgage Industry**

One key thing that the GSEs cannot do is make loans directly to consumers. They are prohibited from that in their charter. Loans are originated by banks, mortgage companies, thrifts, and even REITs. Third party mortgage providers such as mortgage brokers also originate loans for fees, but do not service them. There are thousands of sources for mortgage financing in the U.S. However, in the end, many of the mortgages end up being serviced by the top ten servicers in the country, mostly the big banks and Countrywide Funding Corp. See Figure 4.

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5 Freddie Mac website
6 Although FNMA and FHLMC pass-throughs appear interchangeable in many respects, such as similar collateral, technical factors such as CMO deals, different prepayment speeds and delay days cause them to trade at different prices. FHLMC Gold securities are generally priced a little higher than FNMA, but FHLMC exhibit slightly better OAS and yield numbers because of the FHLMC Gold securities’ shorter days delay.
**Figure 4: Top Ten Mortgage Originators for 2006**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Lender</th>
<th>(in Billions)</th>
<th>Market Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Countrywide Financial, CA</td>
<td>462.50</td>
<td>15.5%</td>
</tr>
<tr>
<td>2</td>
<td>Wells Fargo Home Mortgage, IA</td>
<td>397.64</td>
<td>13.3%</td>
</tr>
<tr>
<td>3</td>
<td>Washington Mutual, WA</td>
<td>195.70</td>
<td>6.6%</td>
</tr>
<tr>
<td>4</td>
<td>CitiMortgage Inc., MO</td>
<td>183.48</td>
<td>6.2%</td>
</tr>
<tr>
<td>5</td>
<td>Chase Home Finance, NJ</td>
<td>172.90</td>
<td>5.8%</td>
</tr>
<tr>
<td>6</td>
<td>Bank of America Mtg. &amp; Affiliates, NC</td>
<td>167.90</td>
<td>5.6%</td>
</tr>
<tr>
<td>7</td>
<td>Wachovia Corporation, NC (Golden West)</td>
<td>104.74</td>
<td>3.5%</td>
</tr>
<tr>
<td>8</td>
<td>Residential Capital Group, MN</td>
<td>96.75</td>
<td>3.2%</td>
</tr>
<tr>
<td>9</td>
<td>IndyMac, CA</td>
<td>89.95</td>
<td>3.0%</td>
</tr>
<tr>
<td>10</td>
<td>GMAC Residential Holding Corp., PA</td>
<td>74.60</td>
<td>2.5%</td>
</tr>
</tbody>
</table>

*Source: RBS Greenwich Capital*

**Mortgage Rates**

While we quote mortgage rates quite freely, in reality there is no single “mortgage rate”. Different lenders offer different rates, different closing costs and points, and potentially different maximum time periods until the loan must close. All of these items affect the borrower significantly. We tend to look at the FHLMC survey of the primary mortgage market (PMMS) for primary market rates. Secondary market rates are easier, as we tend to simply use the “current” or par-coupon pass-through mortgage yield as our rate.

**Non-agency Mortgages**

Any loan over the conforming loan balance ($417,000 for 2006 and so far in 2007) is not eligible for securitization by GNMA or the GSEs. Therefore, these large, or so-called “jumbo” loans are automatically non-agency mortgages. In addition, other characteristics may prevent or discourage a loan from being securitized by the agencies. Other possible reasons the GSEs do not securitize loans are:

- No job, or too little time in current job.
- Poor or insufficient borrower credit – for a couple, the worst credit rating is considered
- Insufficient documentation
- Too low an income for the loan payment
- Too high a combined debt-to-income ratio.
- Not enough liquid assets.

We will take a closer look at non-agency mortgages later in this paper.

**Prepayments**

The critical difference between mortgage-backed securities and other types of bonds is that mortgage backed securities can prepay their principal at any time. However, the homeowner does not efficiently exercise this option. Otherwise, no mortgage backed security would trade much over par!

Complex econometric models are used to project mortgage prepayments. These prepayment models are used in conjunction with term-structure of interest rate models to project future cash flows and value the homeowner’s call option embedded in most MBS. Note that as homeowners’ incentive to prepay increases, so does his efficiency at exercising the prepayment option. This feature results in so-called “negative convexity” of mortgage backed securities (or any callable security). More principal is typically returned at lower interest rates, resulting in

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7 Note that the FHLBs and the Farm Credit bank can purchase these so-called “Jumbo” loans, but they presently do not securitize them for the secondary market. Fannie Mae and Freddie Mac are prohibited by their charter from purchasing these loans.
reinvestment risk and price underperformance versus a comparable bond that cannot prepay/be called. We will be covering these topics in more detail later.

**Chapter 2: GNMA and agency Pass-Throughs**

**Comparing GNMA and the agencies**

There are a few major differences between GNMA pass-throughs and conventional pass-throughs.

- GNMA pass-throughs have the full faith and credit of the US government.
- GNMA borrowers tend to have lower FICO scores (i.e., are less creditworthy) than conventional borrowers.
- FHA loans in GNMA pass-throughs are assumable (roughly 2/3 of loans in GNMA are FHA; the balance are VA).
- Currently, GNMA borrowers pay an additional insurance fee on top of their mortgage rate. That insurance fee is typically 50 bp right now, but moving to a sliding scale based on LTV and borrower credit worthiness is under consideration.

Because of the FHA insurance fee, home price appreciation has a big impact on GNMA, especially slight discounts. If home price appreciation is high, GNMA borrowers typically find it attractive to refinance into a conventional loan, thereby eliminating their insurance fee each month.

**The TBA Pass-Through Market**

Mortgage pass-throughs typically trade in the to-be-assigned (TBA) market. Rather than identify a specific pool or pools of mortgages by CUSIP or pool number, trades are executed by identifying a limited number of criteria, then completed later under a set of parameters (known as TBA guidelines), and actual pool selection is performed two business days before settlement. The following are required for a TBA trade:

- GNMA or agency name (GNMA, FNMA, FHLMC)
- Maturity (10, 15, 20, 30Y, 40Y)
- Coupon
- Settlement month

Note that settlement days within each month are specified in advance by the Securities Industry and Financial Markets Association (SIFMA). The SIFMA sets all parameters for TBA transactions. Mortgage originators are aided by the ability to trade mortgages forward in the TBA market, because they may not close a loan for months after the loan application is accepted. TBA guidelines also force loans to be homogenous in fixed-rate MBS, because most pass-throughs with the same agency, coupon, original term and similar age are interchangeable. Having a TBA market increases MBS liquidity and hence the price originators can receive for their loans.

**Pass-Throughs Use Forward Settlement**

Mortgages usually trade for forward, not corporate, settlement. Different days of the month are chosen to settle the classes of pass-throughs, as shown in Figure 5.

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8 In addition, there are TBA guidelines for 5-year and 7-year balloon mortgages as well as agency hybrid ARMs. The balloon programs have shrunk to insignificance at this point, and we do not cover hybrid ARMs in this publication.
Figure 5: TBA pass-through settlement dates (2007)

<table>
<thead>
<tr>
<th></th>
<th>Class A 30Y</th>
<th>Class B 15Y</th>
<th>Class C 30Y</th>
<th>Class D Balloons/ARMs</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHLMC</td>
<td></td>
<td>FHLMC</td>
<td>GNMA</td>
<td>FHLMC</td>
</tr>
<tr>
<td>FNMA</td>
<td></td>
<td>FNMA</td>
<td>GNMA</td>
<td>FNMA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FNMA</td>
<td></td>
<td>GNMA</td>
</tr>
<tr>
<td>Jan</td>
<td>11</td>
<td>17</td>
<td>22</td>
<td>19</td>
</tr>
<tr>
<td>Feb</td>
<td>12</td>
<td>15</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>Mar</td>
<td>13</td>
<td>19</td>
<td>21</td>
<td>22</td>
</tr>
</tbody>
</table>

Source: Securities Industry and Financial Markets Association

TBA Parameters

Most TBA trades follow these guidelines:

- No more than 3 pools per million dollars of par amount
- Pool allocation and settlement on the day specified during the month by the Securities Industry and Financial Markets Association (called TBA settlement).
- Maximum +/- 0.1% variance of specified par amount is allowed. This variance exists to allow originators some leeway.

Investors can also ask for additional features for a TBA trade, called stipulations or “stips”. For example:

- A specific WALA.
- Maximum number of pools or pieces of pools for the trade. Some investors do not want to process a large number of pools.
- Late delivery, typically 3 days after regular settlement. This delay is often to allow creation of a megapool.
- Different variance, for example 0% or 2%.
- Restrictions on the servicer or issuer of the pool.

Specified Pools

As well as TBA pass-throughs, investors can also purchase specified pools for TBA settlement or otherwise. However, the vast majority of trades are still accomplished in the TBA market. An investor might want to purchase specified pools to gain specific collateral characteristics.

Why would an investor want specified pools?

- CMO issuers promise investors very specific WAC and WALA numbers for their deal collateral. These pools must be purchased on a specified basis or perhaps with a stipulation on a TBA trade that settles before the CMO deal.
- An investor might want to purchase seasoned MBS with a specific WALA and WALA range, perhaps because those loans have better prepayment characteristics than new mortgage pools.
- Only existing pools have prepayment history. An investor might want to examine this prepayment history before actually purchasing them. Sometimes, due to adverse selection, an investor can receive significantly worse pools than the “average” when taking delivery of a TBA trade.
Chapter 3: Credit Enhancement of Agency Pass-Throughs

Credit on US agency MBS is perhaps one of the best in the world. Most investors do not even concern themselves with the credit of these AAA-rated securities. As background for the new investor, we address the sources of credit support as they are called on by the structure.

Mortgage Servicer Advance

As mortgagors become delinquent, the servicer is required by the agency to advance principal and interest payments to the extent they deem them recoverable. A single late or missed payment is almost always advanced by the servicer. After several payments, the servicer needs to judge if they can recover their costs in case of foreclosure. They may cover their expenses for advances (including the negative float) by charging late fees. All costs associated with servicer advances can eventually be claimed to the guarantor of the mortgage pool. The originator also typically has a “representation and warranty” agreement with the agency that the mortgage loans are originated properly (as described and not fraudulent). Note that this includes the appraisal of the property in many cases.

Once the servicer places a property in foreclosure, the servicer no longer has to advance principal and interest. The foreclosure process varies by U.S. state, affecting the time to foreclosure and amount recovered. Hence, recovery varies with more than simply housing prices because the longer the foreclosure process, the worse the recovery percentage generally is. Unpaid interest on the mortgage continues to accrue on the loan and deferred maintenance may reduce the value of the home.

Primary Mortgage Insurance

Primary mortgage insurance is required by Fannie Mae and Freddie Mac on loans with an original LTV over 80%, down to the 75% LTV mark. Ginnie Mae has their own internal insurance program, but note that FHA mortgages (which make up 2/3rds of GNMA pass-throughs) are already 99% guaranteed by the US Government. Primary mortgage insurance protects the investor and the GSEs against market value declines in the property and could also cover some or all of the legal and other costs of selling the home in the event of foreclosure.

GSE Credit

The GSEs guarantee timely payment of principal and interest to investors in the event of:

- Servicer bankruptcy or other problems
- PMI bankruptcy or non-payment
- Foreclosure losses
- Any other issues that would affect timely payment of principal and interest to the investor

Ginnie Mae is backed by the full faith and credit of the US government. Fannie Mae and Freddie Mac are rated AAA and are well capitalized to withstand credit losses in their mortgage portfolios. They even need to “haircut” the support they get from the PMI providers.

Underlying Mortgages

Agency pass-throughs are directly secured by the individual mortgages assigned to each pool. The underlying mortgages are held in trust for the benefit of the MBS investors. Even if a guarantor failed to fulfill their responsibilities or entered receivership, the investor would still have the primary claim on the underlying mortgage assets. Investors would continue to receive principal and interest on the underlying loans — but potentially with principal and interest delays and shortfalls depending on late payments, credit losses, etc.

Note that a mortgage insurer may be in line to pay first.
Chapter 4: Prepayments and OAS Modeling

Mortgage prepayments are critical to understanding and evaluating MBS and their performance. Homeowners are almost all free to prepay partially or in full at any time, virtually all without penalty.

Why Do Homeowners Prepay?

Homeowners typically prepay for the following reasons:

- **The homeowner is refinancing to a lower rate** to take advantage of a lower interest rate available in the market. Note this can be a different mortgage product than the existing loan.

- **The homeowner is moving.** Almost all conventional and jumbo mortgages in the US are due on the sale of the property backing the mortgage. One exception is FHA mortgages underlying GNMA, which are all assumable (the buyer can take over the seller's mortgage with the same rate and terms with minimal paperwork). However, mortgages are rarely assumed now, as loan-to-value ratios fall over time as property prices rise and scheduled principal is paid down. Therefore, a larger down payment is needed to assume a mortgage than might otherwise be necessary with a new loan.

- **Curtailments:** The homeowner is partially paying down principal as a debt reduction strategy.\(^{10}\)

- **The homeowner wants to take equity out of his home** (known as an “equity takeout mortgage” or “cash out refi”). Often this is a debt-consolidation move, and high-interest credit card or home equity debt is rolled into the new first mortgage. Often a homeowner will do this type of refinancing even if the new mortgage has a higher interest rate than his original mortgage.

- **The homeowner is defaulting.** In the current strong housing market, homeowners typically try to sell before allowing foreclosure. However, in some cases the property is not sold in time. Also, in poor housing environments (or neighborhoods!), the homeowner might have “negative equity” in the home.

Prepayment Measurement and Projection

Measuring prepayments is performed by comparing the change in mortgage balances now with some time in the past, after accounting for scheduled principal paydowns.

**CPR,** or conditional prepayment rate, is an annualized measure of prepayments for a specified time period. For example, 20% CPR for the past 12 months means that 20% of a mortgage pool (compounded monthly) has paid off over the past year.

**PSA,** or prepayment standard assumption, is a common measure of mortgage prepayments, especially for CMOs. The PSA curve uses the age of the underlying mortgages (WALA) to assign a CPR speed. Once loans are 30 months old, they are considered fully seasoned and 100% PSA is equivalent to 6% CPR (see Figure 6).

**SMM,** or single monthly mortality, is the monthly, non-compounded version of CPR. It is not commonly used.

\(^{10}\) Once some unscheduled principal is paid down, this causes future “partial prepayments” because the original mortgage payment is not lowered, and is now more than enough to cover interest and remaining scheduled principal.
Inefficient Exercise of the Prepayment Option

A key factor for MBS is that the prepayment option is not efficiently exercised. There are homeowners who move when their mortgage rate is below market\(^{11}\) and would be advantageous to retain. Conversely, there are homeowners who do not prepay even when mortgage rates available are radically lower than their current rate.

Prepayments caused by relocations are called “turnover.” Other prepayments are called “refinancing.” When interest rates drop, we typically see a pattern where prepayments rise very quickly (“spike”) then gradually decline (“burnout”) as the most likely homeowners to refinance are quickly removed from the premium mortgage pools (see Figure 7).

Correlation of Home Prices and Prepayments

Home prices are positively correlated with prepayments. One can argue that whatever the reason a homeowner is refinancing for (equity takeout, rate refi, buying a larger home), higher home prices speeds up the process. For example, homeowners are most likely to move when they have built up sizable equity in their current home,

\(^{11}\) Once a pass-through trades above par, it is theoretically “in the money” to refinance in options terminology. Another way of thinking about this is that the existing mortgage rate is higher than that available in the market for a potential loan refinancing. However, because of the fixed costs associated with refinancing, such as title insurance and appraisal fees, rates must typically go 50 to 75 bp lower than an existing mortgage rate to trigger really fast prepayment speeds. This interest rate guideline equates approximately to secondary market pass-through prices of $102 to $103.
enabling them to trade up to a more expensive home. A decline in home prices generally depresses turnover, and to some extent refinancing. With steep home price declines, even home loans that are technically “underwater” most often do not default, a consequence of individuals’ needing somewhere to live or perhaps trying to preserve their credit ratings.

**GNMA vs. Conventional Prepayments**

GNMA prepayments are different from conventional (i.e. FNMA and FHLMC) loan prepayments due to the GNMAs’ underlying characteristics.

- GNMA loans tend to be higher LTV, closer to 95% than conventionals’ 75%.
- GNMA loans tend to have lower loan balances.
- GNMA borrowers typically have lower FICO scores then conventionals do.

The smaller loan balance for GNMAs means they tend to prepay slightly slower than conventionals for mortgages that are just in the money to refinance. Lower loan sizes means less dollar incentive to refinance.

For discount loans, a lot depends on home price appreciation. If home prices are moving higher, discount (low coupon) GNMAs can prepay faster than conventionals. Homeowners can refinance from GNMAs into conventional in certain programs with only 10% down payments, saving themselves the additional insurance fee that GNMA charges on the entire loan balance.

If home price appreciation is slow and rate move higher, GNMA discounts can prepay more slowly than conventionals. Most loans underlying GNMA securities are FHA loans. According to law, almost all conventional loans must be paid off upon the sale of the residence, known as “due on sale.” On the other hand, a homebuyer can always try to assume an existing FHA mortgage. To assume an FHA mortgage, the would-be borrower would need to submit a full application to FHA and come up with a down payment for the balance of the purchase price.

In practice, the FHA mortgage assumption has not impacted GNMA prepayments significantly over the past decade. Because most GNMA homebuyers want to place a very small down payment, even modest home price appreciation over five years can increase the down payment required to 20% of the home’s value in order to assume an existing mortgage. That down payment sum may simply be out of reach for many prospective FHA borrowers, causing them to take out a new, higher dollar amount, higher rate FHA loan. Note that a typical down payment for an FHA loan is 5%.

**Streamlined Refinancing Programs**

In the 1990s, GNMA and both GSEs introduced streamlined refinancing programs. These programs allowed homeowners to refinance with minimal hassle and paperwork, provided the following conditions:

- The originator refinances the loan with the same agency as the original loan.
- For FNMA and FHLMC, the home price is checked and may not have declined from its original appraisal (using a limited “zip code” appraisal based on original purchase price and generic home price data). For GNMA, home prices are not checked, but the new mortgage payment must be lower than the existing one.
- The loan may not be an “equity takeout” mortgage, i.e. the amount of the new loan may not be larger than the amount outstanding of the old loan.

**No asset, credit or employment checks are performed for streamlined refinancing.** After these programs were introduced, the approximate threshold for prepayments dropped to approximately 50 to 75 bp of interest rate advantage rather than the previous 100 to 150 bp of incentive.

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12 In practice, some of the down payment could be covered by a second mortgage. However, GNMA does not offer this product and borrowers may not qualify for the combined package of first and second mortgages.

13 Sometimes originators allow exceptions if the homeowner is merely capitalizing some of the refinancing fees into the loan balance, creating a slightly higher balance. The GSEs occasionally use an informal cutoff of 105% of the original amount of the loan.
Prepayments and Negative Convexity

Because prepayments generally increase as mortgage rates fall (and MBS prices rise), pass-throughs are negatively convex. One can think of MBS as callable bonds and consider reinvestment risk. If rates fall, callable bonds get called by the “issuer” (or in this case the homeowners via prepayments). Rates are lower, yet the investor might have to reinvest cash, now at a lower interest rate. Total coupon income will clearly be lower than if the bonds had not been called. On the other hand, if rates rise, an investor who had assumed the bonds might be called now has an asset that has a dramatically longer duration than at purchase. Borrowers that might have prepaid their loans may not because they have a relatively low mortgage rate locked in already. Interest rates are higher, and investor cash that might have been reinvested at those higher rates is now unavailable. Whenever interest rates change, a mortgage investor is worse off than if rates were unchanged.

Another way to think about negative convexity is from a price-yield perspective. The lower yields get, the harder it is for MBS to reach higher prices, because homeowners are prepaying their loans and mortgage durations are simultaneously shortening. Figure 8 on the following page shows how the mortgage price rises more and more slowly as the yield on a pass-through falls.

Figure 8: Conventional pass-through 6.5 price/yield graph (using prepayment model)

Econometric Prepayment Models

Market participants can look at current and historical prepayment speeds to have an idea of where bonds they own will prepay. However, changing interest rates make this a difficult problem. Econometric prepayment models have existed since the 1980s and are now part of the standard OAS methodology for analyzing MBS. Prepayment model developers look at historical prepayment patterns and try to use loan characteristics, historical interest rates and economic factors to explain prepayment speeds. For example, even the simplest models today use current market mortgage rates, the loan’s gross mortgage rate and age of the underlying loans as factors to predict future prepayments.

Advanced prepayment models focus more on loan level details such as LTV ratios and FICO scores. They also take into account the “path dependency” of MBS prepayments. A large drop in interest rates will typically trigger a quick spike in prepayments followed by a gradual drop, or “burnout”, of those prepayment speeds over time. For example, homeowners who have already passed up a refinancing opportunity may continue to do so in the future. Many prepayment models also use home prices as an explanatory variable.

Prepayment models are a critical component of OAS models. The term-structure portion of an OAS model will use the cash flows generated by the prepayment model run over different interest rate paths to value the embedded options in the MBS.

14 There are some unusual exceptions, such as super-deep discount pass-throughs. Principal-only strips (POs) generally have positive convexity until they reach dollar prices in the $80s or higher.
Model developers and are constantly updating existing prepayment models and adding models for new mortgage products, as mortgage originators are perpetually innovating. New loan products, electronic applications, different loan approval guidelines, and soon electronic title searches all change the cost, timing and other facets of refinancing.

**Important Loan Features for Predicting Prepayments**

When calculating prepayment forecasts for TBAs, prepayment models must make generic assumptions about certain loan features. However, when specific securities with loan level detail are examined, more information is available allowing for more accurate prepayment forecasts. Here we cover a few of those features and how they may influence prepayment model forecasts or assumptions.

**Loan Type**

Prepayment models clearly separate out FNMA from GNMA, and 15Y from 30Y mortgages. However, some of the new “affordable mortgage” products do not have their own models yet. For example:

- Alt-A or reduced documentation loans tend to prepay slightly slower as “cusp” coupons than regular loans. This is because they are originated with slightly higher loan rates than regular loans. As par coupons, they may prepay slightly faster than regular loans as “credit curing” occurs and homeowners can borrower as “A” credits.

- Interest-first or “IO” loans tend to prepay similar to amortizing loans initially, once corrected for other factors, below. However, as the payment recast date approaches, we expect much faster prepayments, similar to what happens to balloon mortgages.

**FICO Score**

FICO score measures the borrower’s creditworthiness at the time of the loan origination. A higher score is better with 700+ generally considered an “A” quality borrower. Lower credit quality means more difficulty for the borrower to refinance (slower premiums) but faster discount speeds due to credit curing and a higher default rate (which comes through as a prepayment to the investor).

**Loan Size**

The smaller the loan size, the less incentive there is for a borrower to refinance. This occurs not only because the meaningfulness of the monthly savings is lower, but there are also fixed costs to refinancing, including recording fees, and potentially appraisal and title insurance fees. In addition, there is more incentive for mortgage brokers to pursue refinancing of loans with higher outstanding balances.

**The Significance of Short-Term Prepayment Forecasting**

Prepayment numbers for the next few months may not have a significant economic impact on all investors. Nevertheless, short-term prepayment forecasts are critical for calculating the correct dollar roll (financing) cost for a pass-through or mortgage derivative and help determine carry of MBS for all investors. The further a security is from a par dollar price, the more important the prepayment forecast. For a market participant buying a dollar roll (buying the front month and selling the back month), they take in a month of prepayment risk and must value the risk of an unexpected prepayment speed appropriately.

**The Significance of Long-Term Prepayment Forecasting**

Prepayment numbers forecast to the maturity of the mortgages are necessary to value the options embedded in MBS. Only once those options can be valued can MBS be compared to US Treasuries, swaps, or other assets. In addition, OAS provides an important benchmark to compare MBS among each other.
The Impact of Days Delay on Yield

The days delay for mortgages lowers the yield on the security, because compensating interest is not paid to the investor for the delay between the receipt of principal and interest and its payment to the investor. There are two major effects of the days delay.

- The yield of the security is lower due to the delay.
- The parity price of a security with delay (parity is defined as the price where the yield is the same whatever prepayment speed is applied) will be somewhat below par.

A Mortgage Yield Table

Negative convexity is intuitively the tendency of a security’s duration to shorten in a rally and lengthen as prices fall. We can see this by examining a mortgage yield table. Figure 9 illustrates how we expect prepayment speeds to increase in a rally. Also, we can tell that parity price is just over $99-16 by examining the table.

<table>
<thead>
<tr>
<th>Rates</th>
<th>-300</th>
<th>-200</th>
<th>-100</th>
<th>0</th>
<th>100</th>
<th>200</th>
<th>300</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPR</td>
<td>50%</td>
<td>45%</td>
<td>25%</td>
<td>12%</td>
<td>9%</td>
<td>7%</td>
<td>5%</td>
</tr>
<tr>
<td>99-00</td>
<td>6.69</td>
<td>6.63</td>
<td>6.44</td>
<td>6.23</td>
<td>6.18</td>
<td>6.17</td>
<td>6.16</td>
</tr>
<tr>
<td>100-00</td>
<td>5.67</td>
<td>5.71</td>
<td>5.84</td>
<td>5.98</td>
<td>6.01</td>
<td>6.02</td>
<td>6.02</td>
</tr>
<tr>
<td>100-16</td>
<td>5.17</td>
<td>5.25</td>
<td>5.54</td>
<td>5.85</td>
<td>5.92</td>
<td>5.94</td>
<td>5.95</td>
</tr>
<tr>
<td>101-00</td>
<td>4.67</td>
<td>4.80</td>
<td>5.25</td>
<td>5.73</td>
<td>5.84</td>
<td>5.87</td>
<td>5.88</td>
</tr>
<tr>
<td>101-16</td>
<td>4.18</td>
<td>4.36</td>
<td>4.95</td>
<td>5.61</td>
<td>5.75</td>
<td>5.79</td>
<td>5.81</td>
</tr>
<tr>
<td>102-00</td>
<td>3.69</td>
<td>3.91</td>
<td>4.67</td>
<td>5.49</td>
<td>5.67</td>
<td>5.72</td>
<td>5.74</td>
</tr>
<tr>
<td>Avg Life</td>
<td>1.05</td>
<td>1.17</td>
<td>1.85</td>
<td>5.19</td>
<td>8.43</td>
<td>10.24</td>
<td>11.13</td>
</tr>
</tbody>
</table>

Source: RBS Greenwich Capital

Chapter 5: OAS Models

Option-adjusted spread (OAS) models have evolved significantly since their introduction in the 1980s. An OAS calculation compares MBS against a benchmark yield curve (typically Treasuries, agencies or swaps) and then uses a prepayment model and a term structure model to forecast interest rates and value the embedded prepayment option the MBS holder is short. LIBOR OAS (LOAS) is the most common valuation method, comparing MBS to a yield curve built from a combination of Eurodollar contracts and swap rates.

From simple term structure and prepayment models and fixed volatility measures, designers now use sophisticated models for each of these facets of embedded option valuation in MBS. OAS models are now the primary way of evaluating MBS relative value. We still use price analysis, yield analysis, and carry analysis, but OAS holds the primary spot for determining long-term relative value.

Term Structure Models

The term structure model selects and builds the spot and forward yield curves, then uses a specific method to estimate option value. One method is to use a Monte Carlo simulation with a set number of paths, valuing the embedded options in the mortgage along each interest rate path and solving for the “average” option value. Model details can be important, especially for MBS derivatives. Models can be one-factor or multi-factor, can use different assumptions for volatility (e.g. normal, lognormal, square root), can include mean-reversion or not, and can also incorporate volatility in different manners (for example the use of caps, swaptions, and swaption skew parameters). This topic is incredibly complex and we will only deal with it at its simplest level. However, it is important to understand the inputs and biases of the term structure model in your OAS system. Modest changes to
model inputs can make a significant difference in the resulting OAS results. Different models have different biases in terms of what types of securities will end up with higher OASs.

**Volatility**

In an options valuation model, the volatility assumption is very important. Most OAS models on Wall Street use implied volatility from the swaptions and/or caps market. Others use Treasury options' implied volatility. Some models still use at-the-money options and ignore the skew in the options market. A model ignoring a large volatility “smile” (out of the money volatility higher than at the money) could cause deep discount MBS (i.e. those with more out-of-the-money options) to appear cheaper on an OAS basis than they really are.

**Prepayment Model**

The prepayment model is employed along each interest rate path specified by a term structure model. The OAS model uses the prepayment speeds to determine the embedded option cost over each interest rate path, then averages those costs together for a final number. The more detailed information the prepayment model has about the underlying mortgages, the more accurate the forecast.

**OAS Model Uses**

OAS models are a good measure of value in the MBS market. A LIBOR OAS represents the spread you could expect to receive, on average over the long term, by buying MBS and hedging with a basket of swaps and swaptions that match the model's hedge ratios.

However, OAS models vary widely from dealer to dealer and product to product. Some market participants use OAS models to determine relative value among asset classes (e.g. MBS, CMBS and Treasuries). However, others constrain OAS models to a relative value role within agency residential 30Y and 15Y MBS.

We tend to look at OAS numbers in relation to their own history. For example, we will run the OAS for the current coupon pass-through, then compare that to time periods where the average dollar price of MBS has been similar. Figure 10 shows that even current coupon OAS numbers tend to widen when the average dollar price of the mortgage market is high.

**Figure 10: Current coupon OAS vs. average MBS dollar price (conventional 30-year)**

<table>
<thead>
<tr>
<th>Year</th>
<th>$ Price</th>
<th>CC LOAS (GCM)</th>
<th>OAD</th>
<th>Convexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>98.77</td>
<td>-6.778</td>
<td>3.65</td>
<td>-1.56</td>
</tr>
<tr>
<td>2006</td>
<td>97.98</td>
<td>-9.040</td>
<td>3.93</td>
<td>-1.15</td>
</tr>
<tr>
<td>2005</td>
<td>100.53</td>
<td>-6.703</td>
<td>3.09</td>
<td>-1.89</td>
</tr>
<tr>
<td>2004</td>
<td>101.64</td>
<td>6.205</td>
<td>3.40</td>
<td>-1.98</td>
</tr>
<tr>
<td>2003</td>
<td>103.37</td>
<td>13.669</td>
<td>2.34</td>
<td>-1.34</td>
</tr>
<tr>
<td>2002</td>
<td>102.76</td>
<td>13.051</td>
<td>2.60</td>
<td>-1.85</td>
</tr>
<tr>
<td>2001</td>
<td>101.48</td>
<td>6.756</td>
<td>2.64</td>
<td>-1.83</td>
</tr>
<tr>
<td>2000</td>
<td>96.56</td>
<td>-11.576</td>
<td>4.20</td>
<td>-0.73</td>
</tr>
<tr>
<td>1999</td>
<td>99.33</td>
<td>-6.027</td>
<td>3.55</td>
<td>-1.22</td>
</tr>
<tr>
<td>1998</td>
<td>102.21</td>
<td>1.97</td>
<td>-1.97</td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td>100.73</td>
<td>3.21</td>
<td>-1.27</td>
<td></td>
</tr>
</tbody>
</table>

*Source: RBS Greenwich Capital*

**Biases in OAS Models**

While OAS models are one of the best valuation measures we have today, each one comes with its own set of biases. Understanding these biases is very important, no matter which model you are using or what bonds you buy. A term structure model takes as fundamental inputs interest rates and implied volatility. How it ties these together with mortgage rates and forecasts scenarios going forward is critical. Some models run many different, random interest rate scenarios based on these inputs and the model's structure. When evaluating MBS, an OAS model will average the results over the different paths of interest rates generated by the term structure model.
As mortgages have linked more tightly over time with the OTC derivatives markets (swaps, swaptions, caps, etc.), modeling the relationship between these two markets together has become important for correct valuations. OTC derivatives and MBS need to be evaluated using the same term structure model and the same assumptions or erroneous results can be obtained. Below we discuss a few potential issues.

**Prepayment Model Bias**

Prepayment models can be too fast or slow for discounts, current coupons, and premiums separately. They can value limited balance loans too highly or not enough (or at all for older models). They can examine or miss other details such as geography, "at origination" variables, and LTV. Even if the security analyzed is at par, because the model examines multiple interest rate paths, prepayment projections as a discount or premium security are still very important to determining OAS, and other risk characteristics. In the past, some investors have tried to tweak “fast” or “slow” prepayment models by “dialing” the overall model lower or higher. One method is to find the prepayment dial that makes the OAS of an IO and PO for the same Trust the same. This dialing may also be accomplished automatically using a Price of Risk Constant (PORC) model, such as the one available at RBSGC.

**Forward Yield Curve Bias**

Another quirk of OAS models is that in order to stay “arbitrage free”, the base case for future interest rates must be “forward rates”. This means that if the spot yield curve is steep, the forward yield curve will also be steep and much higher interest rates in the future will be the “base case”. This scenario is good for premium securities and IOs in terms of OAS valuation, but is it realistic. We must say it is because it can be hedged out perfectly, but some investors may have a different view and believe OASs for premium MBS are overstated when the yield curve is steep.

**Implied Volatility Bias**

To keep MBS OAS arbitrage free, a term structure model must use implied volatilities from the market. However, over time, implied volatility has been persistently higher than actual (historical volatility). We think of this as the “insurance” premium that Wall Street charges Main Street to buy insurance. Another thought is that this compensates for “fat tails” in the distribution of interest rate moves. In general, this bias will allow investors to (on average) earn more than the OAS stated for a specific bond.

**Volatility Skew Bias**

Certain OAS models do not incorporate the volatility skew into their term structure model. In general, the volatility skew is flat or has a “smile” shape, meaning that out of the money implied volatility is higher than at the money. If the skew is a “smile” and the model does not incorporate it, then deep discount and high premium MBS will be typically be overvalued. This occurs because the out of the money calls and puts embedded in these securities will be valued at the (lower) implied volatility of at-the-money options, undervaluing these embedded out of the money options.

### Chapter 6: Relative Value in Mortgage Pass-Throughs

#### The Mortgage Basis

Over the long run, a high OAS on MBS should be a more attractive purchasing opportunity than a low OAS. In general, this is true. However, OAS is also heavily influenced by the macro-economic environment:

- Are interest rates high or low?
- What is the shape of the yield curve?
- Is implied options volatility high or low?
- Are home prices rising rapidly or stagnating?

In addition, models themselves have biases, as discussed above. In this section, we discuss our philosophy of correcting for biases and finding value in MBS.
Static Analysis

The starting point for many investors is static analysis. MBS are analyzed at varying prepayment speeds, and the yield, average life, and comparison to comparable UST is examined. Perhaps the yield is examined versus potential funding cost. This method of analysis makes the most sense for funded investors who do not intend to hedge out convexity risk. In terms of relative value, one common analysis is to look at the current coupon yield spread over the 5Y UST. While this analysis contains plenty of potential bias (for example, it ignores levels of volatility and yield curve shape), it is certainly a starting point for many investors.

The Mortgage Basis Report

The RBS Greenwich Capital Mortgage Basis Report is available on email or our website after the close each trading day. The main regression model result, displayed in the box in the upper left hand corner, tries to evaluate the cheapness of MBS in the context of the macro and interest rate environment. A positive number means MBS are cheap that many basis points (BP) of OAS, a negative number means rich. The model tries to predict where the balance weighted average LOAS of the 30Y conventional mortgage market should be. We have back-tested the model extensively to show not only that it predicts OAS tightening correctly, but also that when traded upon, it makes money historically both in and out of sample. We will describe some of its features below.

The main factors driving the regression model are shape of the yield curve, average dollar price of the mortgage market, and volatility. We will examine each in turn.
**Shape of the Yield Curve**

The shape of the yield curve is very significant. Mortgage OASs tend to be at their tightest when the yield curve has a modest positive slope of roughly 40 to 80 bp. Extremes for the yield curve are generally considered negative for MBS. When the yield curve is very steep, this reflects an overall market condition of risk aversion (preference for money market products over longer term bonds, for example). When the yield curve is inverted, investors fret that carry for MBS is poor or that banks will stop buying MBS.

![Figure 13: Three year chart of FNMA 5.5 LOAS vs Swap 2s-10s Slope](source)

\[
y = 8.8592x + 102.97 \\
R^2 = 0.7538
\]

**Average Dollar Price of the MBS Market**

The average dollar price of the MBS market is relatively intuitive. When dollar prices are low, issuance is generally low. Refinancing risk is low. Prepayment model risk is low. We typically see insurance companies and other atypical investors buy deep discount MBS as a substitute for corporate bonds. Therefore, OASs reflect the tight end of a 10-year range. Conversely, when dollar prices are high, OASs tend to be high as well as investors become concerned with high supply and prepayment risk, and also the risk that prepayment models may not be predicting fast enough prepayments for those premium MBS. We can divide the past decade into “high” and “low” OAS environments and shows how dollar prices are typically positively correlated with OAS (see Figure 14).

![Figure 14: Average MBS Price vs. Average OAS](source)

Source: RBS Greenwich Capital
Implied Volatility

Many money managers, insurance companies, and other investors cannot trade options. The primary way they can take a view on volatility is to buy or sell bonds with embedded options, such as MBS or callable agencies. Therefore, when volatility is very high and expected to drop, we often see buying of MBS from these investors, which creates a tighter OAS in a higher volatility environment. One can argue that the mortgage market expects “mean reversion” of volatility (which longer term has been the correct view).

Other Regressions on the Mortgage Basis Report

As well as the main “LIBOR OAS” basis model regression, a regression for MBS compared to UST is also available. Each regression is most accurate when applied to a mortgage basis trade with the same hedge – i.e. LOAS means MBS hedge with interest rate swaps, and TOAS means mortgages hedged with US Treasuries. There are regressions that compare GNMA to conventional, 15Y to 30Y mortgages, etc., all using the same basic techniques and inputs. We must caution that the other regressions have also been back tested and are not as consistent as the main, LIBOR OAS, regression, possibly because of less liquidity in other markets, such as GNMA. The coupon analysis available is useful to look at, but generally has a “long term” horizon that ignores an important factor – carry. While conversion of LOAS of coupons to a similar value makes a lot of theoretical sense, it may take so long that carry overwhelms relative value according to LOAS. For shorter-term trading, we also look at price regression models and layer carry over the results for a better short-term picture of activity there.

Price Regression Models

Price regression models are most useful for shorter-term trading using brief periods of data (3 to 6 months) in a consistent market environment. They are notoriously poor at extrapolating price moves beyond the range of recent history. Nevertheless, market participants still trade and use price spreads to evaluate coupon swaps and butterflies (e.g. buying one coupon, say FNMA 6s, and selling the surrounding coupons, say FNMA 5.5s and 6.5s). A high price spread in a coupon swap relative to market level and history indicates that the higher coupon bond is expensive. However, unless directly accounted for in a regression, the following factors make examining a coupon swap on price alone a poor decision:

Coupon switches are market directional, with price spreads typically dropping in a bond market rally.

Yield curve shape has an impact on coupon spreads (especially comparing 30-year to 15-year MBS). A yield curve flattening typically compresses coupon spreads.

An increase in implied volatility theoretically hurts slight premium MBS the most (i.e. the pass-through with at-the-money option), and deep discounts and high premiums much less so (this with out-of-the-money options).

Simple Price Regressions

We can construct a simple price regression by charting the current coupon mortgage rate on the X-axis and the coupon swap on the Y-axis (see Figure 15). This technique would work relatively well if interest rates and volatility remained relatively stable, and therefore can be useful for brief periods of time. However, a move outside the recent range of interest rates, a change in volatility, or a change in yield curve shape could bias the results.
Using Multiple Coupon Swaps to Create Price Regressions

One of the biggest problems with using individual coupon swaps is that the price regressions are difficult to extend past the recent range of prices correctly. One way of correcting for this is to use all the similar coupon swaps in one big analysis. Instead of just looking at 6-5.5 in isolation, we look at all the 50 bp coupon swaps from 5-4.5 to 7-6.5. We show all the coupon swaps and the “fair value” regression line running through them (see Figure 16). We use the same inputs as the regression model to create the fair value line: volatility, shape of the yield curve, and moneyness of the mortgage market.

Dollar Roll Considerations

The dollar roll market can bias coupon swaps to look temporarily or persistently rich or cheap, baffling investors. The financing market in pass-throughs drives value to a great extent.

Intuitively, as a dollar roll moves higher in price (i.e. the price drop between front and back month settlement15) increases, the front month may simply be getting richer because it is in short supply. Alternatively, originators may be selling for the back month to hedge their future mortgage pipeline.

15 Market convention is to refer to the soonest available settlement month as the “front”, the next as the “back”, and three months away as the “out” month.
Characteristics of a mortgage coupon that is “rolling well” are the following:

- The front month OAS will typically be lower than the back month.
- The implied reverse repurchase (repo) rate on the dollar roll at a reasonable prepayment speed is generally between 25 bp and 200 bp better than the market repo rate for generic collateral, occasionally approaches “fail” or a 0% implied repo rate.
- Investors may purchase a coupon rolling special anyway simply because of its financing advantage, which could further compress the OAS.
- Typically, seasoned (WALA) paper trades at a premium versus TBAs. However, when the dollar roll is hot, those pay-ups may disappear as all available collateral, even seasoned paper, is delivered as a TBA into the dollar roll bid.

Most MBS analyses (including OAS) do not factor in dollar rolls. In the following section, we will suggest methods for adjusting the above price regression model for carry, using the dollar roll market.

Adding Each Trade’s Carry Component

The preceding coupon swap analysis works relatively well for short-term trading. However, we have noticed that some swaps remain persistently rich or cheap. This is probably due to persistent technicals with certain coupons. To correct for that, we can use the dollar rolls for each coupon to calculate front-month carry (duration neutral) for these trades. We show the FNMA 6-5.5 swap residual from the first regression model and compare that to the contemporaneous carry of the trade (see Figure 17). Note that as the carry on the trade improves, the security typically gets richer (i.e. the regression line goes from the lower left to the upper right). This pattern makes sense, as a security should be more desirable as its carry improves.

Add each trade’s carry component

![Figure 17: FNMA 6.5-6 Swap Price Regression Model Residual vs. Contemporaneous Positive Carry of Trade](source)

Positive Carry Is Important

Many investors are focused on having positive carry in a trade idea. Most of the time, this is a good idea. Even if you are wrong about relative price changes of the assets, perhaps you made money or at least broke even because of your carry earnings. By “carry”, we mean how much money a trade makes over a given period of time with the market unchanged. “Positive carry” is simply earning more money on your longs than your shorts without re-pricing your assets and liabilities. Entering positive carry trades makes sense in the long run. For example, buying a 2-year credit card ABS versus a 2-year Treasury. After two years, when the ABS pays off, you have

---

16 “Reverse repurchase” refers to an investor lending securities to a dealer as collateral for a loan. The loan interest rate is sometimes at a very attractive level because the security is difficult to borrow. This term is often abbreviated “repo” and market participants refer to the loan rate as the “repo rate”. Much of the repo market is overnight, but longer transactions are also commonplace, called “term repo.”
earned the full 40 bp spread over Treasuries, per annum, in additional income, and you have most likely received par back on either bond at maturity.

Carry trades work best on shorter duration securities. The longer the duration, the more market risk you take. A trade with 3 bp a month of positive carry and a bid-ask spread that swings the trade by 12 bp of return is obviously not much positive carry, and should not be used as the primary value of a trade. Investors need to use their best judgement.

For negative carry trades, simply realize that the ideas may need to work quickly in order to realize a profit. If the trade takes too long to work, profits from price improvement could be eaten up by losses from negative carry.

**OAS Techniques for Coupon Swaps**

Depending on your horizon, there are a number of ways that OAS for coupon swaps can be used. Some investors use patterns of OAS history similar to the way we examined price regressions, above. Other investors use OAS numbers to take a longer-term view, looking at years of OAS data. In general, because an OAS model should properly compensate for changes in the yield curve, volatility, etc. over long periods of time, OAS is a valuable tool. The same analysis using a price regression would be much less valuable, because of the uncertainty of how to handle large changes in yield curve shape or the volatility environment.

For evaluating two coupons, the first question is simply does one have a higher OAS than another? That should be a reasonable, long-term indication of value. However, there are technicals in the pass-through market, so the next step is to examine the pattern of OASs over time. Perhaps one bond has a higher OAS, but also always has a higher OAS (see Figure 18).

![Figure 18: FNMA 6.5 minus FNMA 6 LIBOR OAS spread](image)

Source: RBS Greenwich Capital

**OAS Patterns vs. Rates**

What we tend to focus on more than the raw OAS numbers themselves is the pattern of OASs over recent history regressed versus rates. OAS models can have numerous biases. One significant bias that can be reduced is interest rate bias, via regressing OAS spreads versus the level of rates. Rate bias occurs because the market imputes a different duration to securities than the model does. Hedge ratios of securities can be adjusted to account for this duration bias. We show an example of OAS patterns versus the current coupon mortgage rate, with OAS rising in general as interest rates rise. Note that this methodology does not take into account positive carry (see Figure 19).
Chapter 7: Collateralized Mortgage Obligations (CMOs)

The Collateralized Mortgage Obligation (CMO) market has existed since the 1980s, with the general idea of making MBS more desirable for a broader array of investors. Investors can buy fixed or floating rate bonds (even inverse floaters) of short or long duration. There are classes with highly stable average lives (PACs) and those with high yields but variable average lives (non-PACs). Most investors can find a CMO bond that fits their needs, even if pass-throughs do not.

Start of the CMO market

The first CMO deal was done in the mid-1980s. Its purpose was to take existing mortgage-backed pass-throughs and create bonds of different durations – short bonds for banks and thrifts and longer bonds for life insurance companies. With fully amortizing pass-throughs, scheduled and unscheduled principal is received each month throughout the life of a security, often to the maturity date of thirty years. In a CMO, the principal is divided up into pieces or “tranches”, creating some bonds which receive principal right away (and hence have shorter durations) and bonds that do not, typically resulting in longer durations, as well as an initial period when the investor does not receive any principal, known as “lock out”.

In addition, structuring pass-throughs allowed the issuer to create bonds with more stable cash flow characteristics. Dealers created "PAC" or Planned Amortization Class bonds as an attempt at a "corporate bond surrogate". PACs could attract some investors who were otherwise uncomfortable with MBS cash flow uncertainty.

Now, the CMO market has flowered into many types of tranches for all types of investors, using many types of collateral. The cash-flow priority of tranches can be dynamic, varying based on the path of prepayments. Many other markets, foreign and domestic, use the same financial technology started by the CMO market to securitize everything from consumer to aircraft loans.

The CMO Business

CMOs are created each month because demand from investors is filled by dealers. CMO buyers may want more certainty over the cash flows from an MBS investment than pass-throughs can provide. In addition, the CMO market can offer an investor an opportunity to leverage views on interest rates or prepayments unavailable in the pass-through market. From the dealer side, it is still potentially profitable to buy collateral, create a CMO, and sell the individual tranches. For agency CMOs, the dealer typically pays a fee to the GSE that wraps or guarantees the deal (FNMA, FHLMC, or GNMA). Often, demand for one particular type of tranche (say, short sequentials) is strong. Strong CMO demand may allow dealers to make a profit creating the CMO. Yet that CMO tranche may still be attractive compared to other assets (say, US Treasuries). Often, all of the CMO tranches in a deal are not sold right away, which forces the dealer to hold inventory, and thus take risk.
How Big is the CMO Market?

The CMO market eclipsed its issuance record with a banner $1 billion plus year in 2005, (see Figure 20), followed closely by 2006, and now totals over $2 billion outstanding. A strong housing market until recently, low interest rates, and recent demand for floating rate CMOs have been the factors contributing to these record issuance numbers. Issuance of new CMOs dwarfs that in most other markets, including Treasuries and corporate bonds.

Figure 20: CMO issuance has been rising ($bn)

Source: Bloomberg

Data as of 3/31/2007

Liquidity

The enormous size of the CMO market suggests it should have equally large liquidity. However, lack of homogeneity in the CMO market, and exclusion of CMOs from major bond market indices hampers liquidity. Even the most common tranche types, such as PACs and sequentials, may have subtle differences that result in pricing differences. (We discuss valuing different CMO tranche types in detail later.) The liquidity of CMOs is typically less than mortgage pass-throughs, but perhaps comparable to benchmark corporate bond issues. Specialized derivatives, such as Principal Only (PO) strips often have relatively tight bid-ask spreads, of around an eighth of a point.

Practical Details for CMOs

In this section, we cover practical details such as typical settlement dates and deal “call options” for CMOs. Rules are typically different for CMOs than for corporate bonds, or even pass-throughs. In some cases, rules are different for different types of CMO tranches.

CMO Settlement

Agency CMOs typically settle at the Fed. Non-agency CMOs usually settle in book entry via DTC (Depository Trust Co.). Primary market CMOs typically have delayed settlement, usually at the end of the month, to allow the dealer time to bring in collateral and finish structuring the deal. Secondary market CMO trades are typically done for corporate settlement, presently T+3 business days. It is possible to trade CMOs for other settlements, such as T+1, if necessary.

CMOs pay interest and principal monthly

CMOs pay interest monthly, like the underlying pass-throughs. Tranches that receive principal payments will receive them at the same time as the interest payments. Most CMOs have the same number of delay days as the underlying collateral, for example 45 stated delay days for FHLMC Gold pass-throughs. However, certain tranches especially CMO floaters, may have reduced delay days to facilitate comparison to agency or corporate bonds. The number of delay days for each tranche is printed in the prospectus or available from electronic sources. The number of delay days is important, as that number impacts yield, as interest and principal are returned later, hence reinvestment interest is foregone.
New issue versus secondary markets

The new issue CMO market typically settles as much as one or two months in the future, allowing the issuer to gather the requisite collateral for the deal and complete structuring. Investors in a new deal are typically given proposed characteristics, such as WAC, WAM, WALA, etc. This structuring period also affords the investor the opportunity to buy custom CMO tranches. Most secondary tranches trade for corporate settlement, but settlement can be longer if necessary. While the investor cannot change existing tranches in secondary deals, more information about the tranche, such as historical prepayment speeds, can be valuable to the investor. In addition, tranches can always be re-REMICED, or restructured using them as collateral for a new deal.

Some CMOs have clean-up calls

Some CMO deals (typically non-agency) may contain clean-up calls, which are triggered when only a small portion of the deal remains. The percentage trigger is typically 10%, but certain deals are lower. This feature is typically designed to avoid the burden of high fixed administrative costs for the deal’s trustee when a small amount of bonds remains outstanding. We discuss analyzing deal clean-up calls in the “Analyzing Regular CMO Tranches” section.

Chapter 8: Standard CMO Tranche Types

The crux of understanding the CMO market is learning about the different tranche types and how they are structured. Today, CMO deals are quite intricate, with multiple collateral sources, multiple tranche types, etc. in a complex array for each CMO deal. There are two basic CMO deal types.

- **A planned amortization class (PAC) deal**, where the non-PAC (companion) tranches have highly variable cash flows and average lives, while the PAC enjoys relatively stable, prescheduled cash flows.

- **A sequential deal**, where standard sequential tranches have cash flow priority (i.e. absorb most or all of the principal from the deal) in turn until they are all retired.

These basic types of deals can be altered slightly (such as in a PACquential deal), but there are still two basic flavors. Once the PACs and sequentials are created, they can be divided even further (e.g. into a support floater and a support inverse floater). It is also possible to add other tranches with special features, such as a VADM bond, with a guaranteed short final maturity. Nevertheless, to understand the structure of CMOs, one must always start with that first question of which deal type it is, then examine the collateral and individual tranches.

For each tranche type, we will provide the following information:

- Description
- Example
- Yield table
- OAS and risk measures
- Methods of relative value analysis

Our CMO examples have been constructed mainly for learning purposes, not to illustrate relative value or hedging purposes. They may not correspond to anything trading in the markets currently. We also do not identify deal names for those reasons.

Sequential

A sequential CMO deal typically takes the collateral’s principal and allocates it via time priority to different bond (“tranche”) holders. In a straightforward sequential deal (e.g. without a NAS bond), the first sequential tranche receives all prepaid and scheduled principal from the deal’s collateral until the tranche is retired, then the next

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17 One exception is that MACR structures allow an investor to raise or lower the coupon of a bond by recombining IOs or POs to create a bond with a different coupon and a unique CUSIP. However, economically, the investor still owns the same cash flows.

18 Also known as a “vanilla” bond.
sequential in line starts receiving principal. For example, in a simple three-tranche sequential example, the first sequential could be allocated 20% of the deal’s principal. All principal cash flows would pay down the first sequential tranche to a zero balance while the other tranches received interest, but not principal. Once the first tranche is paid off, the second sequential would receive its principal, and finally the third. Different duration bonds allow investors to choose a shorter or longer duration than the underlying collateral. In addition, the period of time before which a CMO tranche receives principal is known as “lockout”. This lockout feature may be valuable to some investors who do not want to receive (and reinvest) principal for some period of time, or to investors who have a view on the shape of the yield curve.

![Figure 21: Cash flows from a three-tranche sequential deal](Image)

**Source:** RBS Greenwich Capital

### Example

Each sequential bond will have a different modified duration, average life, and projected cash flow for each prepayment assumption tested. In many respects, they react to prepayment changes similarly as the underlying collateral of the CMO deal. Increase prepayments and both collateral and sequentials shorten their average life and duration. There are some important differences between sequentials and collateral:

- The window of time that principal is returned to the investor in a sequential is narrower than that for collateral.
- A sequential can be locked out from prepayments (i.e. the factor remains 1.0) for some period of time. Pass-throughs start to factor down from 1.0 as soon as they are created.
- The last sequential (especially in a non-agency deal) is subject to the clean-up call (typically 10% of the whole deal, but perhaps with half or more of the last sequential tranche still outstanding).
- The coupon on a sequential (or any other CMO) can be structured to be higher or lower than the underlying collateral. Most commonly, the coupon on the sequential is “stripped down” lower than the collateral in order to create CMO bonds that trade below par.

When a sequential coupon is stripped down, that portion of interest from the tranche is diverted elsewhere in the deal. Bond coupons are stripped down in order to lower the price of the sequential bond, although typically the yield of the bond will also fall. CMO shorthand refers to the tranche coupon versus the collateral coupon. For example, a 5.5/6.0 sequential would be a bond with a 5.5% coupon in a deal using 6% pass-through collateral.

Figure 22 compares the yield tables of a full coupon, 6.0x6.0 sequential with a stripped down 4.0x6.0 sequential. Note that the principal cash flows are essentially the same—the principal cash flows on these bonds reacts in the same way to changes in prepayment rates. However, market performance will likely be quite different, due to the longer duration of the 4.0x6.0 tranche. The 4.0/6.0 tranche has a 8.8 OAD versus a 3.0 OAD for the 6.0/6.0 full tranche.

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19 Note that the coupon income stripped off these tranches could become an IO/Ioette tranche, or could be added to a regular tranche with principal to create a premium tranche, for example a 6% coupon off 5.5% collateral.
coupon sequential in our example. When interest (IO) is removed from a tranche, the negative duration associated with the IO is also removed, extending the duration of the remaining bond.

**Figure 22: Comparing the yield tables & OAS of full versus stripped down coupon sequentials**

<table>
<thead>
<tr>
<th>Seq 4.0x6.0</th>
<th>Scenario</th>
<th>-200 bp</th>
<th>-100 bp</th>
<th>0 bp</th>
<th>100 bp</th>
<th>200 bp</th>
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</thead>
<tbody>
<tr>
<td>Prepayment (PSA)</td>
<td>2814</td>
<td>1932</td>
<td>503</td>
<td>188</td>
<td>130</td>
<td></td>
</tr>
<tr>
<td>Price</td>
<td>92-17+</td>
<td>10.10%</td>
<td>8.65%</td>
<td>5.88%</td>
<td>4.96%</td>
<td>4.78%</td>
</tr>
<tr>
<td></td>
<td>93-17+</td>
<td>9.21%</td>
<td>7.98%</td>
<td>5.61%</td>
<td>4.82%</td>
<td>4.68%</td>
</tr>
<tr>
<td></td>
<td>94-17+</td>
<td>8.34%</td>
<td>7.32%</td>
<td>5.35%</td>
<td>4.69%</td>
<td>4.57%</td>
</tr>
<tr>
<td>Average Life</td>
<td>1.31</td>
<td>1.73</td>
<td>4.54</td>
<td>10.16</td>
<td>13.24</td>
<td></td>
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<td>OAD</td>
<td>8.8</td>
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<td>OAC</td>
<td>-2.7</td>
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<table>
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<th>-100 bp</th>
<th>0 bp</th>
<th>100 bp</th>
<th>200 bp</th>
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</thead>
<tbody>
<tr>
<td>Prepayment (PSA)</td>
<td>2814</td>
<td>1932</td>
<td>503</td>
<td>188</td>
<td>130</td>
<td></td>
</tr>
<tr>
<td>Price</td>
<td>100-12</td>
<td>5.44%</td>
<td>5.59%</td>
<td>5.88%</td>
<td>5.97%</td>
<td>5.99%</td>
</tr>
<tr>
<td></td>
<td>101-12</td>
<td>4.64%</td>
<td>4.98%</td>
<td>5.62%</td>
<td>5.84%</td>
<td>5.88%</td>
</tr>
<tr>
<td></td>
<td>102-12</td>
<td>3.85%</td>
<td>4.37%</td>
<td>5.37%</td>
<td>5.70%</td>
<td>5.77%</td>
</tr>
<tr>
<td>Average Life</td>
<td>1.31</td>
<td>1.73</td>
<td>4.54</td>
<td>10.16</td>
<td>13.24</td>
<td></td>
</tr>
<tr>
<td>LIBOR OAS</td>
<td>-29</td>
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</tr>
<tr>
<td>OAD</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
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<td>OAC</td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

Source: *RBS Greenwich Capital*

**Analysis**

Analysis of sequentials falls into two broad categories:

**Analysis of short duration sequentials** that are currently paying, typically as short duration bonds. They may be compared to short agencies, ABS, hybrid ARMs, other CMOs etc. For short duration bonds, investors are typically looking at yield and comparing it to similar duration bonds. In addition, investors need to evaluate the extension risk of the sequential to make sure it is not beyond their risk tolerance if interest rates rise, prepayment speeds slow, and the sequential extends.

**Longer duration sequentials** that are often compared to the underlying collateral. Many characteristics of the sequential and collateral are typically similar: prepayment speeds, duration profile, etc. For long duration bonds, comparison to collateral can be made using OAS or yield analysis, plus potentially a total rate of return analysis that compares expected returns of different bonds under different interest rate scenarios.

An intuitive way to think about premium and discount CMO or pass-through durations is callable agency bonds. As the price of a callable bond goes over par, it becomes harder for the price to rise given a drop in interest rates because of the call feature (in the case of sequential CMOs, faster prepayments). The average life of a high premium callable agency bond will be close to the call date because it is likely to be called. Vice versa for a discount callable average life, which should trade longer, close to the maturity date of the bond, because the bond is unlikely to be called.

Another issue to consider for sequentials is whether there is a NAS in the deal, which will change the cash flow behavior of the sequentials.
Planned Amortization Class (PAC)

The other basic type of CMO deal is a PAC/companion structure. PAC stands for “planned amortization class” and has a relatively stable average life which attempts to mimic a corporate bond with a sinking fund. Each PAC has its own pre-set schedule for its principal pay down. If prepayment speeds were to remain at a fixed speed in a specific prepayment band (the “PAC band”) for the life of the security, the PAC would adhere to its original schedule and behave similarly to a corporate bond with a pro-rata sinking fund structure. Figure 23 shows the amortization schedule for a hypothetical PAC with lockout for just over 4 ½ years.

Figure 23: Amortization schedule for a hypothetical PAC

Source: RBS Greenwich Capital

PAC Bands, Band Drift and Broken PACs

As mentioned above, each PAC has a band, typically expressed in PSA terms. A wider band connotes more average life stability, and bonds with extra-wide PAC bands may be denoted “Super PACs”. If prepayments remained at a level within the PAC band throughout the life of the PAC, it would adhere to its schedule and hence have its expected average life.

Of course, prepayments do not remain constant for two months in a row, let alone the life of a security. Therefore, over time, the PAC bands on a PAC typically drift, generally growing tighter over time.

One example of PAC band drift is during a bout of fast prepayments. If approximately one third of a PAC CMO deal is companion bonds and prepayments increase over the high end of the PAC band, at some point, all the companion bonds will pay off, probably leaving behind at least some of the longer PACs. When the companions are gone, the PACs behave like sequential bonds, and are termed “broken PACs”. In reality, a broken PAC will behave like a named sequential bond with similar characteristics (deal structure, lockout, window, and average life). However, due to the stigma of being “broken”, the broken PAC often trades more cheaply than a similar sequential.

Figure 24 shows an example of a new 6.5 year average life PAC with a band of 105–285 PSA. The PAC is fairly new, but the deal has experienced some prepayments, raising the lower PAC band from 100 PSA TO 105 PSA. Note that if interest rates rise 100 bp, its average life stays at 6.5 years, but up 200 bp it has a small amount of extension risk, extending half a year. However, since all residential MBS are inherently callable, very fast prepayment speeds in a bull market cause the PAC to break out of its PAC band and its duration to shorten significantly.
Figure 24: Example of a PAC (Band 110-250 PSA) Price/Yield Table and OAS Information

<table>
<thead>
<tr>
<th>Scenario</th>
<th>-200 bp</th>
<th>-100 bp</th>
<th>0 bp</th>
<th>100 bp</th>
<th>200 bp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepayment (PSA)</td>
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<td>533</td>
<td>182</td>
<td>129</td>
<td>104</td>
</tr>
<tr>
<td>Price 99-00</td>
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<td>5.88%</td>
<td>5.71%</td>
<td>5.71%</td>
<td>5.70%</td>
</tr>
<tr>
<td>100-00</td>
<td>5.38%</td>
<td>5.48%</td>
<td>5.52%</td>
<td>5.52%</td>
<td>5.53%</td>
</tr>
<tr>
<td>101-00</td>
<td>4.55%</td>
<td>5.07%</td>
<td>5.34%</td>
<td>5.34%</td>
<td>5.35%</td>
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<tr>
<td>Average Life</td>
<td>1.25</td>
<td>2.72</td>
<td>6.57</td>
<td>6.57</td>
<td>7.10</td>
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<td>LIBOR OAS</td>
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<td>OAD</td>
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<td>OAC</td>
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</table>

Source: RBS Greenwich Capital

Figure 25, by contrast, shows a broken PAC originated a while ago. All the companion bonds in this deal have paid off, so the PAC now effectively behaves like a similar sequential tranche. The broken PAC OAS looks higher than the first PAC, partially due to the valuable seasoned collateral underlying the deal and partly due to the stigma of being "broken". Broken PACs tend to trade worst versus sequentials when there is a glut of broken PACs, such as after a rally and sustained fast prepayments. This bond currently does not have a PAC band left, but originally had a band of 100-250 PSA.

Figure 25: Example of a broken PAC (no PAC band left) Price/Yield table and OAS information

<table>
<thead>
<tr>
<th>Scenario</th>
<th>-200 bp</th>
<th>-100 bp</th>
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<th>100 bp</th>
<th>200 bp</th>
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</thead>
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<tr>
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<td>428</td>
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<td>127</td>
<td>104</td>
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<tr>
<td>Price 97-18</td>
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<td>6.47%</td>
<td>5.90%</td>
<td>5.84%</td>
<td>5.81%</td>
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<tr>
<td>98-18</td>
<td>6.64%</td>
<td>6.03%</td>
<td>5.74%</td>
<td>5.71%</td>
<td>5.69%</td>
</tr>
<tr>
<td>99-18</td>
<td>5.63%</td>
<td>5.59%</td>
<td>5.57%</td>
<td>5.57%</td>
<td>5.57%</td>
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<tr>
<td>Average Life</td>
<td>1.06</td>
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Source: RBS Greenwich Capital

Analysis

PACs versus Sequentials

The decision to buy PACs over sequentials or pass-throughs involves a couple of questions.

- Does the investor think the bond market is range-bound or could break out of a range?
- What do implied and actual volatility in the market look like and where are they going?
- Is there a reason to buy stable cash flows? (E.g. easier to hedge for the investor.)
- Is cash flow stability cheap via purchasing PACs?

The answers to these questions can guide an investor towards whether to purchase PAC bonds.

Note that analyzing broken PACs will be similar to sequential bonds. As mentioned before, broken PACs sometimes trade at wider OAS numbers than similar sequentials, creating relative value opportunities.20

Like sequentials, PACs can be compared using OAS analysis, yield, total return analysis, etc. to other MBS or even to agency debentures because of the PACs’ relatively stable nature.

20 Broken PACs tend to trade slightly cheaper than sequentials, perhaps because of the stigma of a “broken” deal.
The PACs take first priority in the cash flow waterfall, followed by PAC 2s, and finally the companion bonds.

**PAC 2**

In some structures, a PAC 2 class is created by adding a tranche similar to a PAC, but below its cash flow priority, and with tighter PAC bands. The PACs have first priority in the cash flow waterfall\(^{21}\), followed by the PAC 2s, and then the companion bonds. If the companion bonds pay off completely and the PACs remain, then the PAC 2s effectively become the new companion bonds.

In return for the tighter PAC band of the PAC 2, it will yield more than similar PACs in the same deal. At the same time, in extreme prepayment environments, the PAC 2 will suffer extension or call risk before the PAC. The PAC 2 bond selected for Figure 26 has a relatively tight PAC band of 140-245 PSA —so tight we cannot observe cash flow stability on this bond in the +/- 100 bp scenarios.

**Figure 26: Example of a PAC 2 (no PAC band remaining) price/yield table and OAS information**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>-200 bp</th>
<th>-100 bp</th>
<th>0 bp</th>
<th>100 bp</th>
<th>200 bp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepayment (PSA)</td>
<td>1625</td>
<td>714</td>
<td>192</td>
<td>133</td>
<td>105</td>
</tr>
<tr>
<td>Price</td>
<td>98-07+</td>
<td>7.78%</td>
<td>6.79%</td>
<td>6.05%</td>
<td>5.99%</td>
</tr>
<tr>
<td>99-07+</td>
<td>6.34%</td>
<td>6.00%</td>
<td>5.74%</td>
<td>5.71%</td>
<td>5.65%</td>
</tr>
<tr>
<td>100-07+</td>
<td>4.93%</td>
<td>5.21%</td>
<td>5.42%</td>
<td>5.44%</td>
<td>5.49%</td>
</tr>
<tr>
<td>Average Life</td>
<td>0.74</td>
<td>1.37</td>
<td>3.98</td>
<td>4.63</td>
<td>8.79</td>
</tr>
<tr>
<td>LIBOR OAS</td>
<td>-44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAD</td>
<td>2.45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAC</td>
<td>-2.41</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Source: RBS Greenwich Capital*

**Analysis**

Investors need to scrutinize PAC-2 bonds closely, as bonds from this class exhibit much more variability of structures, cash flows and values than PAC-1 or sequential tranche types. OAS analysis can help an investor determine if a bond is attractive. Investors need to check that extension and call risk is acceptable. In our example bond, duration extension if rates rise 200 bp is worse than with our example sequential bond.

**Companion (Support)**

The deal pays the companion (support) tranche(s) principal left over each month after the PAC bonds (and other bonds in the deal) have been paid as closely to schedule as possible. If prepayment speeds are fast, excess principal will pay down support tranches once planned principal payments to the PACs and other more senior bonds have been made. Alternatively, if prepayment speeds are very slow, all of the principal may go to the PAC bonds, with the support bonds receiving no principal for that month.

**Example**

The structuring of the companion bond makes for highly variable cash flows and a wide variety of performance characteristics for seemingly similar bonds. Because of their average life variability (negative convexity), companion bond yields tend to be quite high. Figure 27 shows how the average life of the bond can vary widely.

\(^{21}\) A waterfall refers to the legal rules governing distribution of principal and interest in a CMO.
Analysis

Companion bond structures are very deal specific, and OAS models can help determine relative value among them. OAS and hence relative value will be very sensitive to model assumptions, especially prepayments. Discount companions are more popular because they can be sold to retail investors more easily. Figure 27 shows our example companion, with high average life variability, but a big yield. The structure and price prevents the yield of the bond from falling much below 5.83%, even in a rising interest rate environment.

PACquential

A PACquential typically blends characteristics of a PAC and a sequential. A Type I PAC typically has a lower band of approximately 100 PSA, while a PACquential has more extension risk, with a lower band typically around 140 or 150 PSA. While tighter than a regular PAC’s, the PACquential’s PAC band makes PACquentials more stable than a standard sequential tranche.

Example

Our example PACquential has a PAC band of 110 to 245 PSA, within which it has a 4.3-year average life. In this case, the extension risk of the bond down to 100 PSA is minimal. Therefore, the difference between this bond and a regular PAC is not that great.

Analysis

Note that PACquentials are not standardized in the market, even in terms of PAC bands, and so each bond must be examined on its own merits. An investor must carefully examine extension risk of the PACquential below its PAC band, down to as low as 100 PSA. Besides that, all the standard analytical tools apply: OAS, average life variability, and total return analysis.
Z-Bond
A CMO tranche can have different cash flow characteristics (PAC, sequential, PACquential). It can pay principal immediately or defer payment of principal. In addition, it can pay interest immediately or accrete interest payments (add them to outstanding principal). In the case of a Z-bond, initially interest accrues and is added to the principal balance rather than paid to the investor. At some point, once the lockout period is over, the Z-bond starts to pay the investor both interest and principal. Not paying current interest initially extends the duration of the Z-bond.

A Z bond can be created from a PAC, companion, sequential, or other cash flow. Note that the accreted interest that would otherwise have been paid to the Z bond is typically used to pay down principal on another CMO tranche. This technique can be used to create CMO tranches such as Very Accurately Defined Maturity (VADM) bonds with a short legal-final maturity.22

Example
The companion Z bond we have chosen for our example has a dollar price of 85-00, giving it PO-like characteristics, including convexity that is not that negative, and pretty close to zero. Note the wide variation in average lives under different interest rate and prepayment scenarios. This particular bond happens to have a very attractive OAS.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>-200 bp</th>
<th>-100 bp</th>
<th>0 bp</th>
<th>100 bp</th>
<th>200 bp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepayment (PSA)</td>
<td>1806</td>
<td>968</td>
<td>237</td>
<td>148</td>
<td>110</td>
</tr>
<tr>
<td>Price</td>
<td>91-00+</td>
<td>9.81%</td>
<td>7.40%</td>
<td>6.13%</td>
<td>6.02%</td>
</tr>
<tr>
<td>92-00+</td>
<td>9.30%</td>
<td>7.18%</td>
<td>6.06%</td>
<td>5.96%</td>
<td>5.92%</td>
</tr>
<tr>
<td>93-00+</td>
<td>8.78%</td>
<td>6.96%</td>
<td>5.99%</td>
<td>5.91%</td>
<td>5.88%</td>
</tr>
<tr>
<td>Average Life</td>
<td>2.20</td>
<td>5.13</td>
<td>17.31</td>
<td>21.49</td>
<td>23.40</td>
</tr>
<tr>
<td>LIBOR OAS</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAD</td>
<td>14.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAC</td>
<td>-3.76</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: RBS Greenwich Capital

Analysis
There are a few differences when analyzing a Z bond instead of a CMO tranche that is paying interest.

- Is the Z bond currently paying interest and principal? If not, there are some investors that may not buy the bond.
- The OAD of the Z bond can experience extreme swings in different interest rate scenarios because of its ability to accrete interest payments into principal. Duration variability is fundamentally dependent on the underlying tranche type (e.g. PAC or companion).
- The OAD can be much longer than OAD of the collateral, especially in slow prepayment scenarios.

Standard OAS or total rate of return (TRR) analysis should take most of these factors into account, but an investor still needs to understand the supply and demand dynamics for Z-bonds as compared to payers. On our example bond, the OAD is extremely long, over 17 years. The fundamental question to ask is whether an investor would prefer to own this bond or a comparable zero-coupon Treasury bond. Some investors might look at OAS analysis, others might prefer TRR (total rate of return) analysis to help decide.

Note also that Z bonds can be sensitive to changes in prepayment model assumptions. Different prepayment and OAS models will probably give a range of OAS valuations.

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22 A legal final maturity is the last day the investor could possibly receive the final cash flow from a CMO tranche. This date is set at the deal’s inception and assumes no prepayments. Actual maturity for most CMO tranches is typically much sooner than the legal final.
VADM

VADM (Very Accurately Defined Maturity) bonds are structured specifically to have short, well defined final maturities. The interest that, instead of being paid to the Z bond, accretes to principal for the Z bond is used to pay off VADM principal (see Z bond). This cash flow provides a source of principal pay down for the VADM even if no prepayments are received by the deal, however unlikely that may be. In general, the average life of a VADM bond is more stable, and has less extension risk, than a comparable duration sequential bond. VADMs’ short final maturities are guaranteed even if prepayments drop to zero, a highly unlikely event.

Example

Our example bond shows a 5.5 year average life. Even if prepayments drop to zero, the bond will have a 5.5 average life (although this extremely slow prepayment speed is not included in our yield table). Note however, that the premium price exposes the bond to significant risk if interest rates drop significantly and prepayments increase substantially. This VADM has a PAC band of 0-215 PSA.

![Figure 30: Example of a VADM price/yield table and OAS information](image)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>-200 bp</th>
<th>-100 bp</th>
<th>0 bp</th>
<th>100 bp</th>
<th>200 bp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepayment (PSA)</td>
<td>1129</td>
<td>592</td>
<td>188</td>
<td>132</td>
<td>105</td>
</tr>
<tr>
<td>Price</td>
<td>5.43%</td>
<td>5.49%</td>
<td>5.52%</td>
<td>5.52%</td>
<td>5.52%</td>
</tr>
<tr>
<td>100-00</td>
<td>4.80%</td>
<td>5.15%</td>
<td>5.29%</td>
<td>5.29%</td>
<td>5.29%</td>
</tr>
<tr>
<td>102-00</td>
<td>4.18%</td>
<td>4.82%</td>
<td>5.07%</td>
<td>5.07%</td>
<td>5.07%</td>
</tr>
<tr>
<td>Average Life</td>
<td>1.70</td>
<td>3.31</td>
<td>5.46</td>
<td>5.46</td>
<td>5.46</td>
</tr>
<tr>
<td>LIBOR OAS</td>
<td>-15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAD</td>
<td>2.81</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAC</td>
<td>-1.71</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Source: RBS Greenwich Capital*

Analysis

Investors should purchase VADMs if they need extension protection or the guaranteed final maturity—such as for certain mutual funds. In addition, an investor must analyze the magnitude of the call risk of the bond, which can vary widely among different VADMs.

NAS

NAS (Non-Amortizing Senior bonds) are structured very similarly to shifting-interest subordinate bonds, but are not subordinate in terms of credit to other senior bonds. The NAS bond typically makes up 10-20% of the senior bonds in a deal, with the rest typically being sequential bonds. A typical NAS is locked out from principal payments of the first five years, then principal payments are stepped up over the next five years: the NAS receives 20% of its pro-rata share of prepayments in year 6, 40% in year 7, etc. until it starts receiving its full pro rata share of prepayments in year 10. This structure creates a long, stable cash flow, typically with more call protection than PAC bonds.

Example

Our example bond has a long average life because it is fully locked out from receiving principal for the first five years under the base case prepayment speed. It has significant extension protection as it is already a long cash flow.

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23 Pronounced vä’dım
24 Certain investors are restricted as to the maximum legal maturity of the bonds they can buy, as opposed to expected maturity, which is typically much shorter.
**Figure 31: Example of a NAS Bond Price/Yield Table and OAS Info**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>-200 bp</th>
<th>-100 bp</th>
<th>0 bp</th>
<th>100 bp</th>
<th>200 bp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepayment (PSA)</td>
<td>1129</td>
<td>592</td>
<td>188</td>
<td>132</td>
<td>105</td>
</tr>
<tr>
<td>Price</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>99-09+</td>
<td>6.18%</td>
<td>6.14%</td>
<td>6.11%</td>
<td>6.11%</td>
<td>6.11%</td>
</tr>
<tr>
<td>100-09+</td>
<td>5.83%</td>
<td>5.94%</td>
<td>5.99%</td>
<td>6.00%</td>
<td>6.00%</td>
</tr>
<tr>
<td>101-09+</td>
<td>5.48%</td>
<td>5.74%</td>
<td>5.88%</td>
<td>5.89%</td>
<td>5.90%</td>
</tr>
<tr>
<td>Average Life</td>
<td>3.19</td>
<td>6.31</td>
<td>13.15</td>
<td>14.74</td>
<td>15.71</td>
</tr>
<tr>
<td>LIBOR OAS</td>
<td>-2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAD</td>
<td>4.43</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAC</td>
<td>-2.41</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Source: RBS Greenwich Capital*

**Analysis**

Typically, a NAS bond that takes up only 10% of a deal (a “10% NAS”) will have better call protection than a NAS that makes up more of the deal. This can be observed in graphs of WAL sensitivity. Otherwise, NAS bonds are typically compared to long PACs using OAS and TRR analysis.

**Sinkers**

Sinkers are created by taking a CMO tranche and splitting it into a sinker and anti-sinker. For example, a CMO structurer could take a sequential tranche, design a sinking fund bond based on the original tranche’s cash flows, and then what is left over becomes a type of support bond called an anti-sinker. The defining characteristic of a sinker is that it is assigned a principal paydown schedule at commencement of the deal. What differentiates it from the PAC bond are two main items:

- Sinkers are created from a single tranche in a deal, rather than the whole deal, as PACs typically are.
- PACs and PAC-2s have PAC bands inside of which there durations remain the same, while sinkers do not have PAC bands.

**Figure 32: A Sinker Bond is Typically Created by Splitting a Front Sequential into a Stable Sinker, and a Higher Yielding Anti-Sinker Support Class**

Source: RBS Greenwich Capital

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25 We do not cover anti-sinkers separately in this paper, and would refer readers to the “companion” tranche for more information on analysis.
Looking at a typical sequential cash flow and the schedule for the sinker, you can get an idea of how the tranche type is supposed to work. A defined amount of principal is paid off to the sinker each month.

**Example**

This sinker bond has great extension protection and a short average life. It has better call protection than a front-end sequential.

**Figure 35: Sinker Bond Yield Table and OAS**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>-200 bp</th>
<th>-100 bp</th>
<th>0 bp</th>
<th>100 bp</th>
<th>200 bp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepayment (PSA)</td>
<td>1129</td>
<td>592</td>
<td>188</td>
<td>132</td>
<td>105</td>
</tr>
<tr>
<td>Price 99-17</td>
<td>6.14%</td>
<td>6.11%</td>
<td>6.09%</td>
<td>6.09%</td>
<td>6.09%</td>
</tr>
<tr>
<td>Price 100-17</td>
<td>5.24%</td>
<td>5.55%</td>
<td>5.82%</td>
<td>5.82%</td>
<td>5.82%</td>
</tr>
<tr>
<td>Price 101-17</td>
<td>4.35%</td>
<td>5.00%</td>
<td>5.54%</td>
<td>5.54%</td>
<td>5.55%</td>
</tr>
<tr>
<td>Average Life</td>
<td>1.17</td>
<td>1.94</td>
<td>4.32</td>
<td>4.32</td>
<td>4.40</td>
</tr>
<tr>
<td>LIBOR OAS</td>
<td>-2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAD</td>
<td>1.26</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAC</td>
<td>-1.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Source: RBS Greenwich Capital*
Analysis
Sinkers require individual analysis, starting with an examination of what the original underlying tranche was. Comparing them back to the original tranche type is relatively standard procedure. Standard OAS and TRR analysis applies.

Floater
The bulk of CMO collateral used to date has been fixed rate, although ARM deals have become more popular. However, it is possible to take fixed-rate collateral, create a fixed-rate tranche (including the whole deal), then use one of a few techniques to create a floating rate tranche, most often with an interest rate cap.

Floating rate tranches in CMOs are generally tied to LIBOR, although the floater could theoretically be indexed to any market price or rate. One possibility is to use an interest rate swap to create a floating-rate bond.\(^{26}\) However, more likely, a CMO floater is created by the division of a fixed-rate tranche into two tranches, one a “floater” and one an “inverse floater”. The inverse floater's coupon moves down (often in leveraged fashion) as the floater’s moves up (see Inverse Floater).

Key features for a floater include:

- **The index.** One-month LIBOR is the most popular for CMOs, although longer versions of LIBOR are fine. Other indices used are Constant Maturity Treasury\(^ {27} \) indices, such as 1Y CMT.

- **The margin.** This is the spread over the index paid to the investor as a coupon.

- **Caps and floors** on the coupon rate for the bond. Note that these caps and floors are stated inclusive of the margin paid over the index.

Example
Our example bond is a “strip”\(^ {28} \) floater off the whole deal, so its average life profile matches collateral exactly. Note that there is no easy way of hedging the cap risk. If rates are stable, this bond has a 5 year average life, but if rates rise sharply, an amortizing cap with an average life of almost 9 years would be required. This floater has a formula of one-month LIBOR + 46 bp, a cap of 7% and a floor of 46 bp.

![Figure 36: Example of a “Strip” Floater price/yield table and OAS information (LIBOR constant)](image-url)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>-200 bp</th>
<th>-100 bp</th>
<th>0 bp</th>
<th>100 bp</th>
<th>200 bp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepayment (PSA)</td>
<td>940</td>
<td>640</td>
<td>245</td>
<td>155</td>
<td>115</td>
</tr>
<tr>
<td>Price</td>
<td>6.38%</td>
<td>6.18%</td>
<td>6.00%</td>
<td>5.96%</td>
<td>5.95%</td>
</tr>
<tr>
<td>99-13</td>
<td>5.49%</td>
<td>5.62%</td>
<td>5.75%</td>
<td>5.77%</td>
<td>5.78%</td>
</tr>
<tr>
<td>101-13</td>
<td>4.63%</td>
<td>5.07%</td>
<td>5.51%</td>
<td>5.59%</td>
<td>5.63%</td>
</tr>
<tr>
<td>Average Life</td>
<td>1.24</td>
<td>2.04</td>
<td>5.44</td>
<td>7.70</td>
<td>9.21</td>
</tr>
<tr>
<td>LIBOR OAS</td>
<td>-7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAD</td>
<td>0.60</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAC</td>
<td>-1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source: RBS Greenwich Capital</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{26}\) Using interest rate swaps inside CMO deals to create floaters is less common than other techniques. Even using an amortizing swap, there is risk that the swap notional amount does not match the underlying tranche’s balance from month-to-month. Balance-guaranteed swaps exist, but can be expensive.

\(^{27}\) These indices are released by the US Treasury and estimate the yield of a hypothetical Treasury bond with a constant maturity equal to 2,5,10, or 30 years, for example.

\(^{28}\) In this case, a “strip” floater refers to a floater stripped equally off all the cash flows, so the average life profile is identical to the underlying collateral's.
Floating-rate bond analysis is similar to fixed-rate analysis in terms of examining cash flow variability and the bond’s OAS. There are a few other issues unique to floaters:

- An investor needs to decide what index to focus on, from one-month LIBOR out to 10Y CMT.
- The investor should examine embedded coupon caps and floors in the floater. The floor is generally considered to be the bond’s margin unless there is an explicit, higher floor.
- The underlying tranche type (PAC, sequential, etc.) also influences what the spread on the floater should be.

Analysts need to make sure that the term structure model they use correctly values caps and floors. Additionally, an investor can price out an actual cap or floor, perhaps for the expected average life of the security to evaluate if the package of floater plus hedge makes sense relative to other money-market alternatives. Some investors specifically buy floaters with low caps in exchange for higher yield if they have a view of interest rates that makes reaching that cap unlikely.

**Discount margin** refers to the effective spread over the index once the bond’s price and a prepayment assumption are factored in. The discount margin is the nominal spread to the index. An investor would look at discount margin as well as OAS to determine value in a floater.

Effective duration for a floater is a combination of the next index reset and any possible limitation of future resets from caps and floors. A longer time until next coupon reset makes the duration longer, and the more likely limitation of the coupon by a cap is, the longer the duration will be.

**Inverse Floater**

An inverse floater is typically created by splitting a fixed-rate CMO tranche into two tranches, a floating-rate portion and an inverse floater. The key understanding is that the sum of the parts (floater and inverse floater) must exactly equal the whole (the underlying tranche) in terms of both interest and principal payments every month. Please see our discussion of “creation value” below for more information.

A typical coupon formula for an inverse floater might be 17.05% - 2.75 x 1-month LIBOR. As the market interest rate rises, the coupon falls. The number multiplied times the index rate is known as the “leverage” of the inverse floater. The higher the leverage, the longer the OAD of the inverse floater, and the more risk to the owner of the bond if interest rates rise more quickly than expected.

**Example**

Our example is a premium, collateral strip inverse floater. These bonds have both extension and call virtually identical to the underlying collateral, but a very high OAS even given the bond’s 6 times leverage. The yield is very stable across prepayment speeds, but is very sensitive to changes in LIBOR (see Figure).
Figure 37: Example of an Inverse Floater price/yield table and OAS information (Priced at $101-19+, Collateral is 29 WALA FNMA 6.0s)

<table>
<thead>
<tr>
<th>Scenario (PSA)</th>
<th>-200 bp</th>
<th>-100 bp</th>
<th>0 bp</th>
<th>100 bp</th>
<th>200 bp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepayment</td>
<td>940</td>
<td>640</td>
<td>245</td>
<td>155</td>
<td>115</td>
</tr>
<tr>
<td>Libor</td>
<td>4.82</td>
<td>8.69%</td>
<td>9.19%</td>
<td>9.92%</td>
<td>10.09%</td>
</tr>
<tr>
<td></td>
<td>5.32</td>
<td>5.94%</td>
<td>6.36%</td>
<td>6.97%</td>
<td>7.10%</td>
</tr>
<tr>
<td></td>
<td>5.82</td>
<td>3.22%</td>
<td>3.55%</td>
<td>4.03%</td>
<td>4.13%</td>
</tr>
<tr>
<td>Average Life</td>
<td>1.19</td>
<td>1.71</td>
<td>4.65</td>
<td>7.29</td>
<td>8.88</td>
</tr>
<tr>
<td>LIBOR OAS</td>
<td>123</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAD</td>
<td>15.36</td>
<td>Cap</td>
<td>39.24%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAC</td>
<td>-9.5</td>
<td>Floor</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: RBS Greenwich Capital

Analysis

There are a number of possible ways to analyze inverse floaters, including:

- **OAS analysis**
- **Bond creation value**

**OAS Analysis**

OAS analysis is important for analyzing inverse floaters, and as with floaters, inverse floaters have embedded caps and floors. Differences in prepayment models and term structure models are magnified when looking at inverse floaters. The interaction between interest rates and prepayments determines the value of the inverse floater. For example, as market rates fall, the inverse floater’s coupon rises, but prepayments increase, which erodes some of the value of the higher coupon to the bondholder. Effectively, the inverse floater buyer is leveraged to prepayments as well as interest rates, and thus must be careful to examine the effect of variations in prepayment assumptions on bond valuation.

An inverse floater’s OAD relates to the underlying tranche, and is increased by the multiplier of its coupon formula in a linear fashion. In our example bond, the underlying tranche has an OAD of 15.36 and the inverse floater’s multiplier is 6. If the floater had a duration of 0, then the inverse floater’s OAD is roughly equivalent to

\[(1 + \text{Multiplier}) \times (\text{Price of floater}/\text{Price of inverse floater}) \times (\text{underlying tranche’s OAD})\]

or

\[(1+6) \times (100.00/101.61) \times (15.36) = 105.82\]

**Bond creation value** is another method typically used to analyze inverse floaters. The value of floaters is relatively easy to determine, as they are relatively easy to price, depending on cap and structure. Likewise, the underlying tranche for the floater/inverse combination is typically reasonable to price. Given those two prices, the arbitrage-free creation value of the inverse floater can be determined simply, as described below. In Figure 38, we show how an inverse floater and a floater can be compared to the starting bond from which they were created. In the first line, we show how the par amount (principal) of the floater and inverse floater sum to the underlying tranche. Since the underlying bond has a coupon of 6%, the total coupon amount paid to the inverse floater and the floater combined has to total exactly the following each month:

\[6\% \times \text{current face} / 12 \text{ months} = 6\% \times \$633,640,500 / 12 = \$3,168,202.50\]

Effectively, the balance weighted average coupon of the floater and inverse floater must always equal 6%. If we assume the lowest that LIBOR can go is 0%, than the floor on the floater coupon is its margin of 46 bp (from its coupon formula of LIBOR + 46 bp). This floor in turn sets the inverse floaters maximum rate, or cap, because we

---

32 To the extent the floater has an OAD of more than 0, it reduces the OAD of the inverse floater compared to this rule-of-thumb formula.
only have a certain amount of coupon to spend each month. In this case, the cap on the inverse floater coupon is 39.24%, which we can calculate by plugging a LIBOR of 0 into the inverse floaters coupon formula:

\[ 39.24\% - (6 \times \text{LIBOR}) = 39.24\% - (6 \times 0) = 39.24\% \]

The key to creation value analysis is examining the prices of the inverse floater, the floater, and the underlying bond. Investors prefer to purchase inverse floaters in the secondary market at or below creation value. Bonds may trade below creation value in the secondary market because of illiquidity, or perhaps their structure has become undesirable in the marketplace.

On the other hand, if the price of the floater and inverse floater add up to more than the value of the underlying companion bond, that would demonstrate the possibility of arbitrage profit, which would prompt dealers to create more inverse floaters. In Figure 38, that would be demonstrated by the value of the floater and the inverse floater being more than that of the underlying bond.

**Figure 38: Floater + Inverse Floater = Underlying Bond (FNMA 6 Collateral Strip Example)**

<table>
<thead>
<tr>
<th>A</th>
<th>Floater</th>
<th>+ B</th>
<th>Inverse Floater</th>
<th>= C</th>
<th>Underlying</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount issued</td>
<td>$542,192,400</td>
<td>$91,448,100</td>
<td>$633,640,500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coupon</td>
<td>1M L + 46bp</td>
<td>39.24– 6 x 1M L</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cap</td>
<td>7.00%</td>
<td>39.24%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor</td>
<td>0.46%</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price</td>
<td>100.406</td>
<td>101.609</td>
<td>100.578</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yield</td>
<td>5.53%</td>
<td>5.74%</td>
<td>5.80%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAS</td>
<td>-9</td>
<td>123</td>
<td>-7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAD</td>
<td>0.60</td>
<td>15.36</td>
<td>2.62</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAC</td>
<td>-1.00</td>
<td>-9.50</td>
<td>-2.60</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Source: RBS Greenwich Capital*

**Why could the parts add up to more than the whole?** There are reasons that bond creation valuation can break down. For example:

- **The parts are unique and more cannot be created.** For example, once a Trust IO/PO deal is closed, additional collateral cannot be added later to increase the size of the deal. Thereafter, a squeeze in the IO or PO will increase their price in relation to the underlying, which is simply TBA collateral. The IO and PO can never be less than (collateral – transaction cost) for long, as this would create a recombination arbitrage.33

- **One of the parts is getting “squeezed”.** One of the risks of shorting bonds in the IO/PO market is that bonds can be re-securitized and hence lost to potential buyers. For example, if virtually all of the POs in a Trust deal are re-securitized, the remaining POs could be in very high demand to hedge the matching IO. In addition, trust IO/PO sizes can be small enough that they can be easily squeezed.

- **The underlying collateral is valuable.** Sometimes the parts may be compared to the "wrong" underlying bond. For example, comparing a Trust IO and PO to TBA collateral may be appropriate for new Trusts. However, after a Trust deal seasons, the underlying collateral itself may be worth a pay-up to TBAs.

**Use inverse floaters as a trade versus forward rates.** Some investors buy inverse floaters as a trade versus forward rates. If the forward yield curve is different than today’s LIBOR rate, then the two yields can be quite

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33 Typically, an IO and a PO from the same trust can be recombined to form the underlying collateral for a 1/32\textsuperscript{nd} fee and resold as collateral. While this is virtually unheard of in practice, it creates an arbitrage floor for the IO and PO prices, which is important from a liquidity and pricing standpoint. This is much harder to do for floaters and inverse floaters, as both sides of the combination in that case may be harder to find and less liquid, as most inverse floaters do not trade on broker screens, as Trust IOs and POs do.
different. For example, the yield of our inverse floater at unchanged rates is 6.36%. The yield assuming forward rates (which project falling LIBOR) is significantly higher, 8.49%.

**Interest Only (IO) and Principal Only (PO) Tranches**

Interest-only tranches (IOs) are available in different structural forms. The primary one we will discuss is “trust IOs”, in which pass-through collateral is contributed to an IO/PO deal, a GSE (such as Freddie Mac) charges a small fee to wrap the deal, and IO and PO tranches are returned to the dealers involved, in proportion to their collateral contribution. The IO and PO together make the underlying collateral, and are sold at a small pay-up to TBAs, known as the “combo premium”. Note the investors holding the combo can recombine them and get the collateral back upon paying a small fee to the wrapping GSE. This mechanism provides an arbitrage floor price for Trust IO/PO deals. This type of deal is assigned its own unique IO/PO Trust number, hence the name. Alternatively, an IO can also be created by stripping interest off a CMO tranche, which typically result in CMO tranches with IO characteristics.\(^{34}\) Standard Trust IOs tend to have the most liquidity and highest relative prices, as they are large size deals that trade on broker screens, while smaller deals have less price transparency. Excess servicing Trust IO deals usually trade at a discount to standard Trust IOs, for reasons of liquidity, potentially adverse prepayment speeds, and the inability to recombine them back into collateral without an exact Trust PO counterpart.

IOs typically have negative duration, moving down in price as interest rates fall. If rates fall, prepayment speeds tend to rise, and faster speeds hurt the IO holder, who wants the collateral factor to stay as high for as long as possible to maximize future income.\(^{35}\) Once a loan prepayments, it stops paying interest beyond the month of prepayment. In the most extremely negative case, an investor could buy an IO and the entire tranche could paid off in that month. In that case, the IO would receive one interest cash flow and then be worthless.

The PO (principal only) is the principal complement of the IO. Like a Treasury STRIP, a PO must be priced below par to yield more than 0%, as there is no coupon attached to this cash flow. A PO holder would prefer prepayments to be very fast, as principal is returned at 100 cents on the dollar. POs have positive convexity below a dollar price of approximately $85-00 (which is a typical price). The positive convexity of POs makes them useful for hedging purposes, for example many investors buy POs in order to hedge mortgage servicing rights.

**Example**

Figure 39 shows an example of a Trust IO. Since Trust IO and PO pricing is relatively liquid, most of the analysis for IOs and POs will be driven by the investor’s view of prepayments or interest rates versus the market’s view (as represented by IO/PO pricing). IO/PO pricing changes much faster and more often than prepayment and OAS models are updated, and can be used to generate the market’s implied view of prepayments using a PORC (price of risk constant) model, something available at RBSGC. Nevertheless, IO/PO prices fluctuate due to technicals, including short squeezes on certain tranches and perceived differences in the underlying deal collateral. Note how the IO below has a high negative duration and high negative convexity, typical for IOs off near current-coupon collateral.

---

\(^{34}\) Principal can be stripped off a deal and sold as well, but this is unusual for a deal that starts with TBA pass-throughs. The reason IO is stripped off and sold is to set coupons so bond prices are not premiums, but closer to par for the regular CMO tranches. Many investors do not want to buy CMO tranches significantly over a par dollar price.

\(^{35}\) An IO investor is hoping that prepayments are as low as possible to maximize the value of future coupon payments.
Figure 39: Example of an IO price/yield table and OAS information

<table>
<thead>
<tr>
<th>Scenario</th>
<th>-200 bp</th>
<th>-100 bp</th>
<th>0 bp</th>
<th>100 bp</th>
<th>200 bp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepayment (PSA)</td>
<td>1129</td>
<td>592</td>
<td>188</td>
<td>132</td>
<td>105</td>
</tr>
<tr>
<td>Price</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-16+</td>
<td>-47.76%</td>
<td>-10.32%</td>
<td>14.18%</td>
<td>17.38%</td>
<td>18.91%</td>
</tr>
<tr>
<td>22-16+</td>
<td>-49.34%</td>
<td>-11.69%</td>
<td>12.90%</td>
<td>16.10%</td>
<td>17.63%</td>
</tr>
<tr>
<td>23-16+</td>
<td>-50.80%</td>
<td>-12.94%</td>
<td>11.72%</td>
<td>14.93%</td>
<td>16.46%</td>
</tr>
<tr>
<td>Average Life</td>
<td>1.67</td>
<td>2.97</td>
<td>7.59</td>
<td>9.49</td>
<td>10.72</td>
</tr>
<tr>
<td>LIBOR OAS</td>
<td>-42</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAD</td>
<td>-41.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAC</td>
<td>-25.97</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: RBS Greenwich Capital

Figure 40 shows an example PO from the same Trust deal as the example IO. Some investors buy POs for protection against faster prepayments or to buy positive convexity\(^{36}\), but others buy them simply as another way to add a lot of duration to their mortgage portfolio. As the scenario interest rates drop, the PO yield rises significantly, due to increasing prepayments. When investors buy a PO, an investor is buying call options. Some investors compare the alternatives directly to each other.

Figure 40: Example of a PO price/yield table and OAS information

<table>
<thead>
<tr>
<th>Scenario</th>
<th>-200 bp</th>
<th>-100 bp</th>
<th>0 bp</th>
<th>100 bp</th>
<th>200 bp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepayment (PSA)</td>
<td>1129</td>
<td>592</td>
<td>188</td>
<td>132</td>
<td>105</td>
</tr>
<tr>
<td>Price</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75-13</td>
<td>18.71%</td>
<td>10.59%</td>
<td>4.13%</td>
<td>3.26%</td>
<td>2.86%</td>
</tr>
<tr>
<td>76-13</td>
<td>17.74%</td>
<td>10.05%</td>
<td>3.91%</td>
<td>3.09%</td>
<td>2.72%</td>
</tr>
<tr>
<td>77-13</td>
<td>16.81%</td>
<td>9.51%</td>
<td>3.71%</td>
<td>2.93%</td>
<td>2.57%</td>
</tr>
<tr>
<td>Average Life</td>
<td>1.67</td>
<td>2.97</td>
<td>7.59</td>
<td>9.49</td>
<td>10.72</td>
</tr>
<tr>
<td>LIBOR OAS</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAD</td>
<td>17.19</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAC</td>
<td>4.88</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: RBS Greenwich Capital

Analysis

IO/PO analysis using OAS models or other techniques is complex and the market can be subject to technical squeezes that defy fundamental analysis. As IOs and POs are sensitive to even small changes in prepayment or term structure model assumptions, one must be very careful to examine the model used to calculate OASs. Prepayment modeling variables such as seasoning and refinancing burnout\(^{37}\) are magnified many times in analyzing the IO/PO derivative versus analyzing the underlying collateral.

Creation value can also be used to analyze IOs and POs, similar to the analysis of inverse floater/floater combinations. For Trust IOs and POs, at first the combination (combo) typically trades at a small premium above collateral. The combination cannot trade significantly below the price of collateral, because otherwise they could be recombined into collateral (for a small fee) and sold. However, the combination may trade at a price significantly above TBA collateral for a number of reasons:

- For Trust IOs and POs, at first the combination typically trades at a small premium above collateral, primarily representing the fee to structure the deal.
- The underlying collateral is valuable, for example it has seasoning worth a pay-up to TBA collateral.

\(^{36}\) Some investors consider buying POs a way of implicitly shorting the mortgage basis, as higher volatility hurts pass-throughs, but should help a positively convex bond like a PO below an $85 dollar price.

\(^{37}\) Burnout refers to declining prepayment speeds after the initial peak in a refinancing event, as the most rate-sensitive borrowers refinance out of a mortgage pool, leaving less sensitive borrowers.
After new issue, there is a squeeze or scarcity of the IO or PO, which raises the price of the combination in turn. Sometimes POs get restructured in other deals, potentially leaving them dear.

Premium tranche/IOette\(^{38}\) arbitrage is another way to compare relative value of IOs versus regular classes of CMOs. For example, a PAC IO plus a stripped down PAC off the same cash flow should equal the value of the full coupon PAC, or there is an arbitrage. Since many investors are willing to accept tighter spreads in return for lower dollar price PAC bonds, there are often arbitrage opportunities during deal pricings that make the restructuring of a premium PAC tranche into a stripped-down coupon PAC and a PAC IO attractive.

Some investors use POs to hedge other assets, such as mortgage servicing rights (MSR), because of either the positive convexity of the PO or its direct link to appreciation when prepayments increase. In that case, all the above analysis may be performed, but the investor probably also wants to check how well correlated changes in the price of the PO will match changes in the item being hedged. Since the PO is an asset, not off-balance-sheet, FAS 133 does not apply to POs.\(^{39}\)

### Unusual features

Note that IOs can be stripped off of any standard CMO type, for example PACs, creating PAC IOs. A PAC IO will behave like a high yielding PAC within the PAC band, but if prepayments speed up, it will pay off quickly, reducing its stated yield and perhaps creating a loss for the investor. Non-Trust IOs must be examined carefully as to the nature of their cash flows and sensitivity to changing interest rates and prepayments.

### Other Mortgage Structures and Derivatives

We briefly describe below a number of other mortgage derivative CMOs for the sake of completeness, but will not discuss individual examples.

#### TAC

A TAC is similar to a PAC, but with only call protection in the event prepayment speeds are higher than expected. The TAC can have a lot of extension risk if prepayments are lower than expected. TAC profiles differ among structures. Some behave more like PAC-2s. Others look more like companion bonds. The defining characteristic of TACs is they have some call protection.

#### Toggle Floaters

Toggle floaters receive a higher spread over their index as compensation for an unusual cap feature. When a typical floater reaches its cap, the coupon is fixed at that level even as interest rates climb. For example a LIBOR floater yielding 6% today may be capped at a 7% coupon. With a toggle floater, when a specific interest rate strike is reached, say 7%, the coupon drops to zero. The toggle floater in return has a substantially higher spread over its index than a regular floater. Note that duration extension risk in the underlying cash flow increases the risk of a toggle floater.

#### Prepayment Trigger Bonds

Prepayment trigger bonds work similarly to toggle floaters, except that they reference the underlying collateral prepayment speeds instead of interest rates. If prepayments are above a certain trigger level in any give month (e.g. 25% CPR), then the prepayment trigger bond coupon drops to 0% for that month. The compensation to the investor is a significant discount on the price of the security (often a point or more) and thus a higher yield when it is paying interest.

#### Inverse IOs

Inverse IOs are created by stripping some coupon off an inverse floater with no (or a limited amount) of principal. In some respects, Inverse IOs behave like an interest rate floor, in that falling short-term rates should initially

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\(^{38}\) IOette is often used to refer to an IO carved out of a CMO deal, as opposed to a Trust IO.

\(^{39}\) FAS 133 is an accounting rule that discusses OTC derivatives and when they should be marked to market on the balance sheet.
benefit both structures. At times, Inverse IO pricing has been described in relation to floor prices (e.g. 87% of floors). However, Inverse IOs are more like “knockout” floors because if interest rates fall enough, prepayment rates on the Inverse IO’s underlying collateral will speed up and potentially pay down the notional principal of the tranche, reducing the remainder of the mortgage investment to zero when an OTC floor would still be outstanding. Because of their illiquidity and sensitivity to prepayments and interest rates, Inverse IOs are difficult to hedge and value — even more so than regular inverse floaters, trust IOs and POs.

Inverse IOs are highly levered to the investor’s interest rate scenario and prepayment forecast. It is important to analyze how small variations in prepayment or interest rate assumptions (including the shape of the yield curve) change the potential value of a bond, and to incorporate factors such as liquidity and investment horizon into the analysis.

**Jump Zs**

A jump Z is a type of Z bond with an additional feature. A jump Z reacts to prepayments above a certain trigger level by shifting from accrual to paying interest and principal (becoming a “payer”). This feature can be of great value to the investor if the Z bond is currently accreting interest, but could jump and is currently at a discount price. Note that some Jump Zs are sticky, meaning once the “payer” triggers, it continues to pay even if prepayment rates subsequently drop below the trigger.

**Structured POs**

PO cash flows can be structured just like regular tranches. For example, you can have TAC POs, Super POs (companion POs), etc. Analysis is similar to that for PO analysis, except the bonds could be even more sensitive to slight changes in prepayment assumptions.

**Benchmark/Reference REMICs**

Benchmark (FNMA) and Reference (FHLMC) REMICs are issued using a syndication process, similar to agency debentures. Rather than being backed by specific collateral, they reference a pool of loans, are assigned a cash flow schedule based on prepayments from the reference pool, and typically have a shorter maturity than typical CMOs.

Benefits:
- Shorter legal final maturity than regular CMOs.
- Large, diverse collateral reference pool
- Liquidity due to reference status and TradeWeb pricing

**Chapter 9: Non-agency CMOs**

While most investors who can buy agency pass-throughs are also allowed to buy agency CMOs, certain investors cannot participate in the non-agency CMO market. Here, we will describe some of the differences between the two markets (see Figure 41 for a synopsis) and then address some specific non-agency CMO issues.
### Figure 41: agency versus Non-agency CMO Differences

<table>
<thead>
<tr>
<th></th>
<th>Agency CMOs</th>
<th>Non-Agency CMOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit support</td>
<td>Agency guarantee, underlying mortgages, primary mortgage insurance</td>
<td>Credit enhancement (e.g. subordination and excess spread), underlying mortgages, primary mortgage insurance</td>
</tr>
<tr>
<td>Actual delay days</td>
<td>Variable: 0, 14, 24</td>
<td>Variable: 0, 24</td>
</tr>
<tr>
<td>BIS risk weighting</td>
<td>0% for GNMA, otherwise 20%</td>
<td>For AAA-rated tranches, 20%</td>
</tr>
<tr>
<td>Collateral types</td>
<td>Agency pass-throughs, conforming Alt-A loans</td>
<td>Jumbo or other non-conforming pass-throughs, re-performing loans, Alt-A loans</td>
</tr>
<tr>
<td>Prepayment model</td>
<td>Agency prepayment model</td>
<td>Specialized model based on collateral</td>
</tr>
<tr>
<td>Subject to interest shortfall</td>
<td>No, compensating interest paid by the Agencies</td>
<td>Compensating interest may be paid or not, or paid up to a specified limit</td>
</tr>
</tbody>
</table>

Source: RBS Greenwich Capital

### Agency CMOs

Agency CMO analysis tends to be simpler than for Non-agency CMOs because of more homogenous, established prepayment models and minimal credit risk. Collateral information disclosure on non-agency CMOs is typically more detailed down to the individual loan data. Non-agency CMOs typically include credit support in the cash flow structure, which also makes each deal unique and analysis complex.

Agency CMOs are generally structured by a dealer, who takes all the risk on the deal. They will approach an agency to “wrap” the deal for a fee. Occasionally, the agency will also purchase some of the CMO tranches in a deal. Fannie Mae and Freddie Mac do exert some control over the new issue CMO market, because at times in the past, they have handed out quotas for the amount of collateral that can be structured into CMOs according to coupon. This restriction is to prevent a potential shortfall of collateral for deals pricing in the same month.

### Non-agency CMOs

The investor is required to do some extra work for non-agency CMOs. One of the main issues is credit, and work can be easily reduced by buying “super senior” classes that add additional credit support beyond that required by the rating agencies. However, there are still other issues of collateral and structure. The whole loans backing these non-agency CMOs do not trade tick for tick with agency collateral. In general, larger loans are perceived to have greater prepayment sensitivity. For credit, liquidity and convexity reasons, jumbo whole loan packages typically trade behind similar agency collateral by $0-18 to $1-00 as compensation for these risks.

### Non-agency Disclosure Requirements

SEC rule AB requires a substantial amount of disclosure on prospective non-agency CMO deals, and reporting on existing deals from the same issuer. This data is typically available on dealer or originator web sites and can help an investor understand the underlying collateral for historical and current deals better. Disclosure typically includes detailed data down to the individual loan and borrower level.

### Non-agency CMO Credit Risk

An investor in senior Non-agency CMOs is taking direct mortgage credit risk, albeit typically on Aaa/AAA rated bonds. Non-agency CMOs are often created from collateral that is non-conforming for the agencies, such as

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40 The underlying pass-throughs are guaranteed by an agency. However, the trust set up to hold the collateral for the CMO cannot have a agency name on it unless it is specifically wrapped by a agency. Without the FNMA, FHLMC, or GNMA name, a CMO would probably have less liquidity despite the fact it only contained only agency pass-throughs. Having the wrap also obligates FNMA/FHLMC/GNMA to step in if there is a problem with the CMO deal’s trustee, or some other unforeseen matter, and make the CMO investor whole.
“jumbo” loans that are over the loan ceiling for the Fannie Mae and Freddie Mac, for 2007 set at $427,000. Certain loans, such as conforming balance Alt-A loans, can be securitized in the non-agency or agency market, depending on execution price to the originator. Originators typically originate and pool non-agency loans together and then sell them to Wall Street dealers. Loans can be sold as “whole loans” without structuring or by using a dealer to structure and sell them in CMO form. In this case, the deal is typically sold off an issuance shelf of the broker/dealer or the originator, pursuant to SEC Rule 415\(^4\).

**Non-agency CMO Credit Enhancement**

Typically, whole loans are not credit enhanced, but sold as a package either “servicing retained” by the originator, or “servicing released” to the buyer. The buyer takes all credit risk on the loans. Non-agency CMOs are usually structured by creating a class of senior securities with a Aaa/AAA rating using some form of credit support. The most popular form of credit support is senior/subordination, as described below. Some other methods that have been used in the past are not typically seen in non-agency CMO deals today, but we also list them below. One exception is deals securitized by lower quality loans that still may use over-collateralization and/or excess spread (see below for definitions). Below, we divide credit enhancements between “internal”, subject primarily to collateral credit performance, and “external”, subject to potential third party upgrades/downgrades. Most investors prefer “internal” credit enhancement.

**Internal credit enhancements:**

**Subordination.** With subordination, classes are lined up to take losses, first in an unrated tranche, all the way up to the AAA senior tranche. If losses are sufficient to extinguish a subordinated class, the next most senior class would then stand in line to absorb losses. If all the subordinated bonds were extinguished, the senior Aaa/AAA tranche would then have to start taking future credit losses. If the deal performs well for a certain period of time (typically 5 years), some of the excess credit support may be released to subordinated bond holders or the residual holder, known as a “step down”. Subordination may also be combined with other types of credit enhancement, most typically excess spread or reserve funds (see below for definitions).

**Over-collateralization.** In this case, excess collateral backs the deal. Therefore, losses on the underlying collateral must “eat through” all the excess collateral before the senior bonds can take a loss. Any excess collateral when the CMO is called or matures is typically returned to the originator or residual holder.

**Excess spread.** Interest income on the loans absorbs losses before any other internal credit enhancement is used. (Note that primary mortgage insurance will still be paid before excess spread is used.) On a monthly basis, additional interest income may go to a reserve fund, back to the originator, or to a residual holder.

**Reserve fund.** Cash is placed in a escrow account and is used to absorb loan losses. Cash can be placed in the account at the start of the deal, can be built up over time (typically using excess spread), or a combination. The reserve fund may build to a target level over time, after which excess cash may be returned to the originator or residual holder, depending upon the specifics of the deal.

**External credit enhancements:**

**Parent guarantee.** The issuer (dealer or originator of the loans) guarantees loans in the deal against credit losses. A parent guarantee makes bonds vulnerable to an issuer’s credit downgrade, which explains this structure’s lack of popularity in the Non-agency CMO market. Rather than for the whole deal, a parent may guarantee buyout of loans with specific problems (e.g. fraud, early payment default, insurance failure). Note that this is effectively the credit enhancement method used for agency CMO deals, although the wrap is by an agency or GSE.

**Letter of credit.** A financial institution provides a guarantee to cover a deal’s losses up to a specific dollar amount for the life of the deal. This type of CMO is vulnerable to a downgrade for the letter of credit provider, as well as typical issues such as collateral underperformance.

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\(^4\) SEC Rule 415 (“shelf registration”) speeds allows issuers to register sales of securities for up to two years in advance, as long as the size registered for can reasonably be expected to be used. When securities are issued under this rule, the typical 30-day cooling off period is typically waived by the SEC. Since the arbitrage (or profit) for creating a CMO may exist for a brief period of time, shelf registration or exemption from SEC registration is essential in the new-issue CMO business.
**Senior/Subordination Remains the Most Popular**

Subordination is the credit enhancement of choice for non-agency deals today, as this method of credit enhancement lets the issuer transfer credit risk on the collateral completely to the market via the subordinated tranches. Although senior-subordinated enhanced CMO deals can be downgraded with poor collateral credit performance, there is minimal downgrade risk outside of that issue.42

**Subordinated tranches**

In this section, we briefly discuss subordinated tranches. Investing in subordinated tranches involves a lot of nuances, and we are only trying to convey general information here. While some subordinates are suitable only for very sophisticated mortgage investors with their own default modeling methodology, others may offer better cash flow stability than many other available MBS, but with a credit rating below AAA. Characteristics of subordinated tranches vary widely depending on structure and rating, but we present a few rules of thumb.

**Single-A and Higher Tranches – Focus on Cash Flows**

For tranches rated single-A and higher, the cash flow performance of the tranche in different prepayment environments is typically more important than the credit characteristics. Often, a subordinated tranche can have better convexity than even agency PAC bonds. Subordinates are typically prohibited from receiving principal for some period of time (most often five years, for credit enhancement purposes), and also have relatively strict schedules for returning principal. These schedules are designed to prevent subordination levels from falling too low and risking a credit downgrade on the deal, but can have the side effect of making bonds with better convexity.

**BBB and Lower Tranches – Focus on Interaction of Credit and Cash Flows**

For tranches rated roughly BBB and below, credit characteristics can dominate or interact strongly with cash flow characteristics. Combinations of interest rate projections, loss, and prepayment projections need to be used under varying scenarios to determine value. Downgrade and losses are clearly possible, but tranches can be money good even with poor collateral if subordination is sufficient and prepayments are quick. Note also that these bonds have much smaller sizes and are less liquid than the more highly rated subordinated tranches. Note that most non-agency CMO deals include an unrated, first loss tranche. The issuer often retains this unrated tranche as a sign of their faith in their loans and the CMO structure.

Subordinated bonds protect the senior bonds in a number of ways:

- Senior bonds are paid principal before the subordinated bonds. Senior bonds also have interest priority over subordinated bonds. Over time, a deal typically “de-levers”, meaning that the actual credit support available increases until the first step-down.
- Senior bonds are not allocated any losses until and unless all other forms of credit enhancement, including subordinated bonds, are exhausted.

**Shifting Interest Subordinates**

The percentage of subordinate bonds in the deal is typically managed over time by using a set of formulas shifting the percentage of principal that gets paid to the senior versus the subordinated bonds. This is known as “shifting interest”. One example would be a subordinated tranche receiving no principal for 5 years, then 20% of its pro rate principal in year 6, 40% in year 7, until it receives 100% of its pro rata principal in year 10.

Figure 42 shows an example of a shifting interest subordinate. Note the very good call protection versus most MBS. Even at 800 PSA, the subordinate still has a 6.4 year average life, relatively long for a CMO under that fast a prepayment speed.

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42 One risk is the bankruptcy of the originator of the loans. If loans were then found to be fraudulent, loan documentation was inadequate to service the loans, etc., then a deal might be downgraded. In addition, bankruptcy of a deal servicer can put stress on a deal in terms of missing payments or payments sent to the wrong place. The rating agencies cover and rate almost all servicers.
Credit Support and Impact of Losses

Different collateral types

There are a number of different collateral types we will discuss briefly in this section. In most cases, their prepayment characteristics are different than agency pass-throughs or typical jumbo whole loans. Better prepayment characteristics generally results in a pay-up over jumbos, worse credit or prepayment characteristics can mean a discount to Jumbos.

“Interest First” or “IO” Loans. Quickly becoming the standard in the non-agency market, these loans require no principal payments for a period of time before amortizing the balance of the loan over the rest of its life. For example, a common structure is a 10yr/20yr IO loan, where interest only is paid for the first 10 years, then the payment resets upwards to fully amortize over the remaining 20 years. Because of the payment shock after 20 years, the rating agencies generally require more credit enhancement for a deal with more IO fixed-rate loans. Prepayment characteristics are quite similar to amortizing collateral once loan size and FICO score are accounted for. For more information, see the following RBSGC paper: Fixed-Rate IO Loan Prepayments available in the white papers section of our website at:


Re-performing FHA/VA loans. In general, these are originally FHA or VA loans that were seriously delinquent that have since been cured or modified. The underlying credit issues with the loans typically cause them to be less reactive to interest rate moves, and hence desirable to investors from a cash flow analysis standpoint. Note that the original FHA or VA guarantee typically does not apply to loans that have been bought out of GNMA pools, so an investor needs to check credit details carefully.

VA Vende. These loans are typically made at very high LTVs (up to 100%) to non-veteran borrowers purchasing real estate owned by the VA that is typically acquired through foreclosure. These homeowners have started with a below-market interest rate and a very high LTV, so they are probably less sensitive to an interest rate rally in terms of refinancing.

Alt-A loans. The Alt-A label has been applied to a broad swath of mortgage types. In general, we would characterize these loans as slightly below top-credit mortgages, with rates up to 50 bp above the rate for “prime” borrowers. These loans are primarily classified as “limited” or “stated” documentation, where the borrower is missing a standard credit history, documented source of income, or some other standard input used in credit scoring models. This often occurs with younger borrowers or immigrants. Alt-A borrowers are thought to be less sensitive to an interest rate rally than Jumbo borrowers. Note that, overall, Alt-A prepayments may be higher then agency prepayments over time, as borrowers “cure” their credit problems and refinance into lower rate, standard documentation mortgages. The important factor is that this credit curing is not necessarily correlated with interest rates, thus the collateral is typically considered more valuable than standard jumbo loans.
**Alt-B loans.** If a loan has a FICO score under 650-660 or has a rate 50 bp or more higher than the “prime” mortgage rate, we consider it to be Alt-B instead of Alt-A. The difference between Alt-B and subprime is small. Many Alt-A deals have a small amount of Alt-B collateral in them.

While lower credit quality loans have been securitized, this is generally considered an asset-backed product, Home Equity Loans.

**Other Non-agency CMO Issues**

There are a few other issues with non-agency CMOs that differentiate them from agency CMOs. We have mentioned servicing and originator risk if they have financial problems. Non-agency mortgage prepayments tend to behave differently than agency mortgage prepayments. We cover other issues, such as compensating interest, below.

**Compensating interest**

In a non-agency CMO deal, loan prepayments received before the end of the month result in an interest shortfall from that day until the end of the month for that loan. The borrower does not pay interest for the balance of the month once the loan is paid off, yet the CMO deal is structured to pay interest on the original balance for the entire month. In agency deals, this shortfall is made up by the agencies on the underlying pass-throughs. In non-agency deals, there are several ways that this issue can be handled.

- The servicer, originator or deal sponsor makes pays compensating interest. This structure most closely resembles the standard agency CMO structure, except the deal is now subject to the credit rating of the compensating interest provider. Often, the amount of interest in a single month is limited to servicing fees received for a month on the deal, effectively capping the risk to the compensating interest provider and raising an additional risk for the investor, especially in times of fast prepayments.

- Create a regular CMO tranche or tranches which absorb the risk of the interest rate shortfall.

- Create a WAC IO, similar to a regular IO/IOette off a CMO deal, except the coupon of the IO may vary from month to month to absorb any interest shortfalls.

**Servicer and bankruptcy risk**

While CMOs are structured to be “bankruptcy remote” from the issuer and originator, there can be risk if the servicer has financial problems. Securitization structures are designed to insulate investors from the impacts of a seller/servicer bankruptcy by legally isolating the mortgage loan collateral, however the potential bankruptcy of a seller/servicer in a Non-agency CMO does pose some less obvious risks.

- Assuming the seller/servicer’s bankruptcy makes them an undesirable party to continue to service the loans, transfer to a new seller/servicer may create a problem, or at least disrupt payment servicing and collection.

- If loan payments were commingled with the servicers general funds (typically against policy), then some loan payments to the CMO could go missing, especially in cases of fraud.

In the case of an agency CMO, the agency would be responsible for solving any servicer problems, in addition to shouldering the risk by guaranteeing timely payments of principal and interest to the investor. Moreover, if the servicing fee is too small on a non-agency deal, the trustee may have to extract payment from bondholders in some fashion. The servicing industry has consolidated into a smaller number of large, sophisticated servicers and there is less risk that any one of them having problems would cause a widespread problem.

**Jumbo prepayments**

Jumbo mortgage prepayments tend to behave differently than agency mortgage prepayments, primarily because the larger loan size of the jumbos makes refinancing more economical, even for smaller interest rate incentives. The fixed costs of refinancing (filing fees, lawyer’s fees, etc.) are proportionally smaller for a Jumbo borrower versus a conforming borrower. Also, for the same interest rate savings, a Jumbo borrower would have a larger present value of future monthly payment savings simply because of the larger loan amount. Large loan size hence tends to increase refinancing efficiency, and hence raise the option cost to the investor. Higher yields on Jumbos
are designed to compensate investors for this heightened prepayment risk, as well as for the lack of agency backing.

Collateral Dispersion/Concentration

Collateral dispersion can be an important issue for non-agency CMO buyers. For example, dispersion can occur in the following areas:

- **FICO scores.** Having even 5-10% of loans with FICO scores below 650 can significantly impact the credit quality of a deal and the amount of credit support the rating agencies will require.

- **Gross Weighted Average Coupon (Gross WAC).** WAC dispersion means that some higher coupon loans in the deal will be more sensitive to a drop in interest rates than the WAC suggests.

- **Geographic area.** A concentration of loans in a specific state, and especially a specific zip code, is a concern. Regional economies and home prices are more volatile than national ones. In addition, a natural disaster could have a larger impact on a deal if it hit an area of geographic concentration for the deal.

**Chapter 10: Relative Value and CMOs**

The following section looks at how investors analyze and use CMOs. Different investors have different needs, goals, and analysis techniques. There are many different types of CMOs. We cover analysis for regular and derivative CMO tranches with a focus on different techniques and the unique needs of broad classes of investors such as banks, insurance companies, and total return managers.

**Analysis for Standard CMO tranches**

The definition of relative value can be different for different investors, and thus analysis techniques vary. Some investors have portfolio constraints in terms of duration, final maturity, or for other reasons. For example, a short-term bond mutual fund may not be able to buy bonds with a final maturity of more than five years.

**Investor goals and constraints**

Investors typically have many goals and constraints when purchasing CMOs. For example:

- Hedge funds may require a certain amount of liquidity or transparent pricing for purchases they make, both for bonds and potential hedges (such as cancelable swaps). An otherwise attractive trade idea may be turned down for liquidity issues.

- Funded investors such as the GSEs may need to issue debt or even raise equity capital before adding more MBS. For example, if debt issuance is expensive to the issuer, then CMO purchases could be delayed.

- A bank may require CMOs to pass “FFIEC”, a test initially set up by U.S. bank regulators to guide banks towards better convexity CMOs. Regulators no longer require banks to conduct FFIEC tests, but some banks still employ these tests internally.

- Insurance companies, banks, or other investors sometimes have yield levels (“bogies”) below which they choose not to purchase bonds.

- Some investors may require a certain minimum OAS for a CMO, or a specific OAS pickup versus collateral.

- Individual or institutional investors may have a top dollar price limit, above which they will not purchase bonds.

Perhaps the varying needs of investors explains why there are so many different kinds of CMOs, some unique. Different requirements and views are what make a market…

**Cash flow analysis**

For most CMO tranche types, cash flow analysis consists of testing a bond under various prepayment models and static prepayment assumptions to determine the sensitivity of its cash flows to changes in interest rates. Many investors would compare that bond to the underlying collateral, or to other investment candidates. For some
investors, cash flow analysis is more detailed and important, as they may be trying to hedge a specific stream of liabilities. Other investors may be hedging a CMO with OTC derivatives, such as amortizing swaps.

Finally, for non-standard tranches, an investor should examine the cash flow waterfall and test various interest rate scenarios, examining weighted-average life (WAL) charts and the resulting cash flow streams. Some potential issues that require close examination are:

- Cash flows that are more variable than a typical bond of the same type. An example would be a NAS-affected sequential.
- A payment window that is interrupted by a period of receiving no principal pay downs.
- A long expected final maturity (wide payment window).
- An average life profile that changes sharply at a particular prepayment speed, or one with an unexpected shape.
- A bond that responds in an unusual manner to a spike in interest rates or prepayments. Obviously, this includes toggle floaters and bonds that include prepayment triggers.

**OAS analysis**

For most CMO tranches, OAS analysis is quite useful for determining relative value. The absolute OAS number is an indication of value versus the underlying curve – typically swaps or UST, but also perhaps agency debt. One can use OAS to determine the relative value of similar CMO bonds. If the CMO is similar to collateral, one could also perform that comparison. The more difficult issue is how to compare OAS numbers among tranches of different types and durations. For example, sometimes longer duration tranches are at higher OAS numbers than similar shorter tranches, making it difficult to evaluate relative value of longer versus shorter CMOs. One suggestion is to compare CMOs to similar duration collateral or other non-mortgage bonds to determine relative value. For CMOs with very long durations, such as inverse floaters, CMO tranches can be compared to Treasury bonds, agency debentures, or leveraged collateral positions.

**Examining deal call risk**

An embedded call (the “clean-up call”) appears in most non-agency CMO deals and has been present in agency deals as well. Note that the issuer or the residual holder typically holds this call option, which effectively lets the option holder buy any remaining collateral in a deal at par, if they so wish, once the deal drops below the minimum balance threshold. The call is intended to curtail the monthly fixed costs of administering a deal once that fixed cost relative to the amount of remaining bonds becomes onerous. While a call typically does not impact holders of short tranches, it can have a big impact on investors in longer-duration tranches. For example, the last cash flow holder will probably be exposed to the call. A call that sounds small for an entire deal (say, only 1%), should actually make up a much larger proportion of the last tranche remaining in a CMO deal. In an extreme example, a tranche that is only 1% of the deal would be instantly callable when all the other tranches are paid off.

The good news is that clean-up calls are exercised most of the time, even for bonds at modest discount prices, because the fixed costs of the deal tend to be large enough that the trustee or residual holder wants to exercise the call whenever possible. This assumption makes analysis easier. However, if the price of the collateral is significantly below par, calling the deal may cost the call owner money. For such deals, analysis of the probability of exercise of the call is difficult as the true nature of the call holder may not be apparent. Therefore, the bond holder may want to analyze sensitive bonds both with and without the call to assess its possible impact.

**Non-agency CMOs**

An additional item for non-agency CMOs is the underlying collateral’s price relationship to TBAs. For example, we show the price discount for AAA Jumbo 6s versus FNMA TBA 6s (see Figure). This price relationship is governed by supply and demand technicals, as well as fundamentals such as perceived prepayment differences.
Chapter 11: Investor Types and Behavior

In this section, we examine different types of investors, such as insurance companies and commercial banks. Our goal is to cover the following information for each:

- Different types of MBS typically purchased by these institutions.
- Analysis techniques potentially used by these institutions.

Figure 44 shows that foreign investors and banks are the two largest holders of MBS, followed by the GSEs and money managers. Other investors include pension funds, insurance companies, non-financial corporations, and private individuals. These investors also hold large amounts of CMOs.

Banks

Banks are large buyers of CMOs and pass-throughs, both agency and non-agency. Some banks are large buyers of pass-throughs because they want the liquidity. However, for many banks, the duration or duration extension liability of pass-throughs does not match their liabilities or risk profile. Rather than hedging unwanted risk in pass-throughs or whole loans, it is easier for many banks to reduce risk or shorten duration by buying the right CMO. Banks typically hold CMOs for a long period of time, often until maturity, although some bonds may be placed in the bank’s trading account.
In general, banks hold shorter average-life CMOs. A bond longer than 5 years does not typically fit the liability structure of a bank. Certain banks focus on CMO floaters as well as fixed rate bonds. A front sequential CMO is a typical purchase for a bank. In general, banks will happily accept convexity risk in order to earn a higher spread over LIBOR. Therefore, banks tend to prefer sequentials or other higher yielding tranches over more stable, lower yielding tranches such as PAC bonds. Banks tend not to hedge their negative convexity using the options market, although they may delta hedge their mortgage position as interest rates move and the CMO position’s duration changes.

During periods of economic and credit deterioration, banks tend to restrict loan making, for example in commercial and industrial (C&I) loans, and they tend to purchase MBS instead. We show how risk-based capital guidelines for banks favor MBS over corporate bonds and municipal bonds (see Figure).

<table>
<thead>
<tr>
<th>Asset</th>
<th>Capital Guideline</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>FNMA/FHLMC MBS</td>
<td>20%</td>
<td>No explicit government guarantee</td>
</tr>
<tr>
<td>FNMA/FHLMC debentures</td>
<td>20%</td>
<td>No explicit government guarantee</td>
</tr>
<tr>
<td>GNMA MBS</td>
<td>0%</td>
<td>Full faith and credit of the US government</td>
</tr>
<tr>
<td>Treasuries</td>
<td>0%</td>
<td>Full faith and credit of the US government</td>
</tr>
<tr>
<td>Triple-A asset-backed</td>
<td>20%</td>
<td>Recently reduced from 100%, effective 1/1/2002</td>
</tr>
<tr>
<td>Triple-A CMBS</td>
<td>20%</td>
<td>Recently reduced from 100%, effective 1/1/2002</td>
</tr>
<tr>
<td>Whole loan mortgages</td>
<td>50%</td>
<td>Capital advantage when banks securitize loans</td>
</tr>
<tr>
<td>Single-A corporate bond</td>
<td>100%</td>
<td>Special rules are in place for high yield bonds</td>
</tr>
<tr>
<td>Single-A municipal bond</td>
<td>100%</td>
<td>Most issues are not tax deductible for US banks</td>
</tr>
</tbody>
</table>

Source: RBS Greenwich Capital

Non-US banks operate somewhat differently than US banks in the MBS market. First, many non-US banks tend to buy floating rate instead of fixed-rate assets. In MBS, they may buy adjustable rate mortgages (ARMs) or CMO floaters. Non-US banks with capital constraints prefer GNMA securities at 0% risk weight over FNMA or FHLMC pass-throughs with 20% risk weight because they are not required to hold any additional risk-based capital against the purchase of GNMAs.

In general, a bank will have a target net interest margin over their cost of funds in order to purchase a security. This number may correspond to a certain return on capital, for example. This target may be translated into a yield or spread bogey over a market rate, such as LIBOR. Some banks use OAS to determine relative value among CMO tranches, but in general asset-liability and (sometimes) liquidity concerns tend to dominate their CMO investing decisions. Although regulators no longer require bonds to be FFIEC eligible, some bank boards or portfolio managers may restrict themselves to bonds that meet the FFIEC tests as a general test of “prudence”.

Note also that banks are the largest consumer of mortgage “whole loans”, or mortgages that are not securitized. These whole loans are often ineligible for agency securitization.

**Banks: The FFIEC test**

For a period of years in the 1990s, regulators restricted banks from buying CMOs with significantly more convexity risk than pass-throughs. This rule was enforced by applying the rule-based “FFIEC test” to a CMO. This pass/fail test is still available on Bloomberg using the FMED <Go> command, as shown in Figure 46. The test limits the acceptable CMO average life variability and projected price change in +/- 300 bp parallel interest rate shocks. The CMO passes if its value changes by less than 17%, up or down. In addition, the CMO’s starting average life could not be longer than 10 years, and the bond could extend by no more than 4 years nor shorten by more than 6 years. Even though the test is no longer applied by the regulators, some investors feel it still provides a suitable benchmark of whether a CMO is “risky” or not.

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43 “Delta hedging” consists of trading a hedge on a frequent basis (often daily) to offset position changes of an options or mortgage holding. Delta hedging a long options position makes money over time as trades are done, delta hedging a negative convexity position such as a long mortgage position loses money over time as trades are done.

44 Note that although it no longer is applied by regulators to bank CMO portfolios, some bank investors still use it as a general guideline to make sure they are not buying bonds that are too volatile.
The housing GSEs (Fannie Mae and Freddie Mac) are sophisticated investors that will buy and hedge almost any pass-through or CMO, as long as it is cheap enough versus their debt. The GSEs often use OAS or comparisons to collateral to determine value and determine hedges, but also have a keen sense of historical relative value and practical hedging. They may buy CMOs off valuable collateral when the underlying collateral is unavailable. They can hedge issue debt (including callable debt) against CMOs that they purchase for their portfolios. They can also use OTC derivatives to hedge assets or modify liabilities to better fit assets that they purchase. The GSEs are relative value investors and can sell bonds when they feel they are expensive, but net buying is more typical.

Some GSEs (such as the twelve FHLBs) have the ability to buy non-agency MBS. The FHLBs operate more like a bank in some cases, caring as much about yield, net interest margin and average life profile as they do about relative value in an OAS framework. The FHLBs typically pay member banks, so credit losses or other impacts on income are particularly problematic.

**Money Managers**

Many money managers are marked to market daily and benchmarked against a mortgage pass-through index which includes agency fixed-rate pass-throughs and hybrid ARMs. This is the starting point for investing for most money managers. From there, money managers vary in sophistication and investment strategies. They generally are not subject to gain/loss constraints because they mark-to-market daily, unless they are managing a separate account for a financial institution. Some money managers are active in the CMO derivatives market, but many are not. Most money managers are benchmarked against an index which contains only pass-throughs. Therefore, any CMO is effectively an “out of index” bet for them. They will typically be comparing that CMO either to collateral, or perhaps, for certain types of CMOs, to Treasuries/agencies. OAS analysis tends to be an important tool for money managers.

Liquidity tends to be a bigger issuer for money managers than for insurance companies. The money manager may need to be able to shift assets around quickly, and thus is prepared to give up something in order to have better liquidity. Most money managers own many more pass-throughs than CMOs because of this fact. In addition, pass-
throughs have the opportunity to finance special (via the dollar roll market). Income from special financing can be a windfall for money managers, as this income is typically not included in the mortgage index returns against which the money managers are benchmarked.

Money managers frequently take long-term views about strategy in mortgages. One type of view is to have a portfolio that has better (or worse) convexity than their benchmark index. A money manager can typically get better convexity by buying PAC bonds, or give up convexity by buying companion bonds or certain types of sequentials or broken PACs.

**Insurance Companies**

Insurance companies buy most types of pass-throughs and CMOs across the yield curve. Property and casualty companies tend to buy shorter maturity CMO tranches, such as 2 year sequentials. Life insurance companies are looking for more structure and a match against their long liabilities and thus are more likely to purchase longer duration bonds, such as 10Y PACs, as well as pass-throughs. Variable annuity managers may behave like money managers. MBS provide diversification from the corporate bonds that form the bulk of most insurance company general accounts (taking convexity instead of credit risk). In 1995, S&P devised a “convexity test” that penalized insurance companies from a ratings standpoint for having negative convexity in their portfolios. This development served primarily to reduce mortgage holdings at some particularly large “outlier” firms that held unusually high percentages of MBS, but has also generally reduced MBS holdings over time at insurance companies. This test is still in use and is occasionally updated. Additionally, insurance companies may have restrictions on selling CMOs because of gain or loss constraints. Property and casualty companies may sell bonds to pay claim losses (after an earthquake, for example).

**Pension funds**

Pension funds in some ways operate similarly to money managers, but may have a different duration benchmark. ERISA (pension fund law) or investor considerations sometimes prohibit insurance companies from investing in mortgage derivatives or taking too much credit risk. Similar to life insurance companies, they are often interested in longer duration CMO tranches to defease long-term liabilities.

**Hedge funds**

Hedge funds are typically trying to earn money outright, not versus a benchmark. They can operate in a manner similar to money managers, but at times they enter into much more complex trades. For example, a hedge fund might buy a CMO and try to hedge its cash flows over time using callable amortizing swaps, netting a positive spread which they hope to earn over time.

Certain hedge funds specialize in mortgage derivatives: inverse floaters, super floaters, IOs, POs, inverse IOs, etc. They use sophisticated internal and external models to value these tranches and hedge them. One of the main issues for these funds is accurate pricing of their inventory (as individual bonds may not trade for months), correct hedging, and sufficient liquidity.

**Retail Investors/Regional Dealers**

Regional dealers buy CMOs, including high yielding derivative tranches. In turn, these regional dealers may sell those bonds to small institutions or retail clients. Since high yield tends to be the focus of these buyers, companion bonds are often sold via this channel. Pass-through trades are less important for regional dealers.

Note that any broker that sells CMOs to a retail investor must include a series of special disclaimers mandated by the NASD.

**Non-US Investors**

MBS provide an ideal opportunity for non-US investors to pick up yield in the US markets without sacrificing credit quality or liquidity, even versus Treasuries in the case of GNMA. Non domestic investors are significant
participants in the US MBS and agency market (see Figure). Recently, Asia has been the largest non-domestic investor.

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2005</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSEs</td>
<td>-47</td>
<td>-163</td>
<td>-100</td>
</tr>
<tr>
<td>Banks</td>
<td>77</td>
<td>36</td>
<td>96</td>
</tr>
<tr>
<td>Non-domestic*</td>
<td>207</td>
<td>220</td>
<td>57</td>
</tr>
<tr>
<td>Net Issuance**</td>
<td>273</td>
<td>86</td>
<td>-42</td>
</tr>
</tbody>
</table>

* TICS data, includes agency debt securities
** FNMA, FHLMC, GNMAI 30Y & 15Y net issuance

Source: Fannie Mae, Freddie Mac, Federal Reserve, Bloomberg, eMBS

** Originators **

Originators accept applications for loans and pay cash to the homeowner at the loan closing for the home purchase or refinancing. After the loans close, most originators swap groups of conforming loans for MBS from FNMA, FHLMC or GNMA. Non-conforming loans are sold as whole loan packages or into CMO deals. Mortgage originators are mortgage investors, at least until the loan closes and they sell the securities created. Many originators are also mortgage servicers, which will be covered in the next section.

Originators have to manage their pipeline of new loans (known as pipeline risk). There are two key issues:

- Not every accepted application closes and becomes a loan. Some applications are dropped by the applicant, called pipeline fallout. Sometimes this is because the buyer or seller cancels the transaction, which is probably not related to changes in interest rates.
- Pipeline fallout increases when the bond market rallies (borrowers apply for a new loan at a lower rate) and drops when the bond market sells off (borrowers make every effort to close the loan with a now advantageous rate). This represents negative convexity on mortgage commitments before they even close and become loans for the originator.

Some originators buy mortgage put and call options to hedge the risk of pipeline fallout. Originators typically dynamically buy and sell pass-throughs in the forward market to hedge their pipeline risk.

** Servicers **

Servicers mail mortgage bills to the homeowners, collect mortgage payments and possible late fees and escrow payments, then forward the cash to the owner of the mortgages or a trustee for the owner. In return, the servicer receives a small portion of the interest paid on each loan, typically a minimum of 12.5 bp of coupon annually on each loan for non-agencies, paid in monthly installments. However, if a loan is prepaid, this ongoing fee will no longer be received by the servicer, as their services will no longer be required.

Each loan that is securitized via the GNMA program has a 43 bp servicing fee. Loans in FNMA and FHLMC programs have variable servicing fees, typically averaging 40 bp. Excess servicing on a group of loans can be resold, or servicing can be released entirely to another servicer upon sale of the loans.

Mortgage servicing rights (MSR) have the following conditions of ownership:

---

45 As we go to press, the minimum servicing fee for agency MBS is 25 bp, although this may be reduced to 12.5 bp in the future. Non-agency deals are 12.5 bp minimum currently, by convention.
46 Here, we are referring to the GNMA I program, which is currently the largest, most liquid program from GNMA. The GNMA II program is smaller, includes ARMs and has variable servicing fees.
47 Excess servicing is currently above the 25 bp currently required for agency loans. Excess servicing may be securitized by the servicer as a Trust IO off agency collateral, typically the best and most liquid execution.
The right to collect the servicing fee from each loan remaining in the pool each month. Following the month that loans prepay, servicing is no longer received for that loan. Overall servicing for a pool is reduced over time as the outstanding aggregate mortgage balance on which the fee is based is reduced.

The servicer has the right to keep the float (interest earned) on mortgage payments received until the date they need to submit them to the trustee for payment to the investor. Similarly, the servicer may keep money in escrow for taxes or insurance and can keep the float on that. Servicers also charge and keep late fees. These are not passed through to the investor.

The servicer receives intangible (and difficult to value) benefits through their financial relationships with their mortgagors. For example, a servicer might link a demand deposit account to some mortgages or arrange mortgage insurance for an additional profit.

The servicer is obligated to advance principal and interest on a timely basis for delinquent loans as long as it is reasonable and prudent to expect recovery of those funds at some point (e.g. through the foreclosure process where repayment of these advances has first priority).

After reviewing the four items above, it is clear that the main value of the servicing is typically the servicing fee itself (also known as an interest rate strip to differentiate it from the other servicing benefits), as well as the float. The servicing fee is often compared to owning an interest only (IO) security. Hedging IOs or servicing is notoriously difficult, and has driven some servicers into bankruptcy. During times of large prepayment speed increases, some servicers are inevitably forced to take write downs on their servicing portfolios despite using the best available hedging techniques.

Servicing, like IOs, is typically quite negatively convex, as the servicer is short a call option to each borrower. Purchases of options and/or intense delta hedging of a servicing portfolio are typical techniques to counter negative convexity. In addition, IOs and servicing typically have negative duration, meaning their price falls as interest rates fall. Therefore, servicers typically hedge by purchasing mortgages, Treasuries or receiving on interest rate swaps.

Servicers tend to be OAS model-driven. IOs and servicing are extremely complex instruments. Also, servicing does not trade hands often, necessitating internal or external pricing models for servicing.

Lessons from the past

Liquidity for CMOs can dry up in a market crisis such as the summer 1998 Russian Debt Crisis or on September 11, 2001. Pass-throughs may continue to trade, but derivatives may not. Investors should be prepared for all risks, including the risk of illiquidity and significant drops in bond prices. Dealers must make sure they “know their customer” and that the customer is buying bonds appropriate for their goals.

Chapter 12: Affordability Mortgage Products

Forty-Year Loans

FNMA and FHLMC now securitize forty year mortgage loans. The idea is that a forty year loan has a payment roughly 5% lower than a 30-year amortizing loan, extending the length of the loan in return for a more affordable payment over the full life of the loan and a fixed interest rate.

Fixed-Rate Interest Only Loans

The interest-only loan has exploded onto the scene over the past few years. In a typical 10year/20year “Fixed rate IO”, the borrower pays only the interest on the loan for the first 10 years, then the payment recasts upwards to make the loan amortize fully over the remaining 20 years. The payment reduction available via these programs is substantial. While initially, there was a significant interest rate premium charged to the borrower for these loans, they have become standard in hybrid ARMs, are clearly mainstream in Jumbo loans, and are climbing in acceptance in the agency pass-through world.
Hybrid ARMs

We will not go into detail here, but Hybrid ARMs become very attractive to borrowers when the yield curve is steep. Most hybrid ARMs are now interest-only for some period of time, making the initial payment vary affordable, and the shock when the payment resets a significant issuer.

Chapter 13: CMO and Pass-Through Practical Trading Information

We have covered TBA pass-through characteristics and types of CMOs earlier in this paper. However, we still need to discuss some other practical information, including financing of MBS.

Dollar Rolls/Financing

The financing market drives value in the pass-through market to a great extent. Similar to the way Treasury issues can go “special” in the repo financing market, specific pass-through coupons (for example, FNMA 5s) can have special financing. However, the vast majority of financing in the mortgage market occurs through the dollar rolls rather than the repo market, which is also available. The primary differences are as follows:

- A dollar roll is a simultaneous purchase and sale of substantially similar (TBA agency, coupon, and maturity) securities for different settlement dates. A repurchase agreement requires redelivery of exactly the same securities, in the same original face amounts.

- A dollar roll transaction where the investor is financing pass-throughs transfers prepayment risk to the dealer, who must attach a prepayment assumption to the dollar roll and weigh the risk of forecasting error. Exactly the same par amount of securities is returned in a dollar roll (within TBA variance guidelines) regardless of prepayments. In a repo transaction, the security owner bears the prepayment risk, not the dealer.

- Special financing in the dollar roll market is almost never available in the repo market. This occurs because often the bonds purchased are locked into a structure, such as a CMO. In a repo transaction, the securities borrower is required to return the exact securities at the end of the transaction, impossible if they are already placed in a structured deal.

Dollar Roll Example

Most dollar roll purchase and sale dates conform to the same dates as standard TBA mortgage delivery, one day a month for each settlement class. Consolidating all agency pass-through trades into a single settlement day per class each month greatly increases the liquidity of the mortgage market. It benefits mortgage originators who need time to close mortgages before they can convert commitments to loans and then securities. It also benefits market participants such as dealers who wish to short mortgages (perhaps as a hedge), because the standard MBS market is a forward-delivery market. A market participant can short pass-throughs in the forward market without needing to find securities to borrow (as in the Treasury or corporate bond markets).

Our example compares a dollar roll versus financing using the reverse repurchase (repo) market. One of the critical assumptions when comparing the two is to estimate the prepayment number for the bonds in question for the length of the dollar roll (most often only one month). Once holding that assumption, one can compare the repo rate implied by the price drop from the starting to the ending month to the rate offered for general mortgage collateral in the repo market.
Liquidity Considerations

An investor must always consider their liquidity needs and the liquidity of different MBS markets before entering into a transaction. For “buy and hold” investors, liquidity only needs to be sufficient to acquire a block of bonds of the right size at the right price in a reasonable period of time. For investors that trade actively, the bid-ask spread of different products becomes critical. For example, the current coupon TBA pass-through typically trades in a ¼ tick market. Many investors trade in and out of a pass-through position during a single day, or even multiple times a day. However, a mortgage derivative may trade with a bid-ask that is much wider, discouraging investors who want to be in and out of a trade in a brief period of time. In times of crisis, bid-ask spreads may widen substantially on mortgage derivatives, prices may fall, and some less liquid bonds may stop trading altogether for a period of time.

Frequency of Principal and Interest Payments is Typically Monthly

Interest and principal payments are typically paid monthly in arrears for pass-throughs and CMOs. There were some older CMO deals that tried to structure themselves like corporate bonds, with semi-annual coupon payments, but compensating interest becomes a problem under such structures.

Chapter 14: Hedging MBS

Once an investor buys some pass-throughs, the next decision to make is how to hedge them. Pass-through hedging can range from a simple, short-term solution of selling a single on-the-run Treasury note to extremely complex hedging with a basket of swaps and swaptions.

Hedging MBS Duration

Unlike corporate bonds or bullet agency debentures, mortgages have an additional dimension. Their duration changes as interest rates move, impacting their price and projections for prepayments. In this way, they are similar
to callable agency debentures. Often, market participants’ estimates for hedge ratios will vary significantly for a specific MBS, even the current coupon pass-through.

**Using OAD**

Option-adjusted duration (OAD) is generally a good starting point for determining the duration hedge for a mortgage. The problem is that different OAS models will give different OADs for the same security.

An investment account benchmarked to the mortgage index has fewer problems, because the portion of the investment that matches the index is *de facto* guaranteed to match the duration and performance of the index. For an indexed money manager, the difficulty in hedging occurs when overweight or underweight different mortgage coupons in the MBS portfolio, or when considering CMOs.

**Empirical Durations**

An “empirical duration” measures what would have been the best hedge ratio over some period of history, generally reflecting the right hedge for the “average” level of interest rates over that time period. One can compare empirical durations with OADs and trader hedge ratios to get an idea of how mortgages have been trading recently. Empirical durations are usually calculated by specifying a time period (typically one to three months) and taking a regression of the daily mortgage price change versus the daily hedge price change, then multiplying that coefficient (beta) times the hedge duration to get the empirical duration for the mortgage.

One cannot necessarily use recent empirical durations as an accurate hedging tool. If interest rates have been trending in one direction, the empirical duration will not reflect the best hedge at the end of the time period selected. The empirical duration always reflects a hedge for the average interest rate of the period covered, not the most recent interest rate.

**Optimal Hedge Ratios for Pass-Throughs**

We find that the empirically best way to determine hedge ratios is to apply an empirical scaling factor to daily option-adjusted durations (OADs) of mortgage pass-through securities. We call this “adjusted OAD”. Empirical testing shows these hedge ratios reduce daily tracking errors versus empirical durations, OADs (The Yield Book, GCM, and PORC), and trader (subjective) hedge ratios.


A comparison of optimal hedge ratios versus OAD-generated hedge ratios and trader hedge ratios is shown below.

<table>
<thead>
<tr>
<th>Adj. OAD (UST)</th>
<th>OAD (UST)</th>
<th>Trader (UST)</th>
<th>Adj.OAD (Swap)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Y 5 Y 10 Y 5 Y</td>
<td>10 Y 5 Y</td>
<td>10 Y 5 Y</td>
<td>10 Y</td>
</tr>
<tr>
<td>4.5 0.68 1.00 0.66 1.17 0.63 1.12 0.68</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.0 0.60 0.88 0.58 1.03 0.58 1.03 0.60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.5 0.47 0.69 0.46 0.82 0.47 0.84 0.47</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.0 0.30 0.44 0.31 0.54 0.33 0.59 0.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.5 0.15 0.23 0.20 0.36 0.15 0.27 0.15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.0 0.07 0.12 0.16 0.29 0.06 0.11 0.08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.5 0.03 0.04 0.22 0.40 0.02 0.04 0.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.0 0.00 0.00 0.23 0.41 0.00 0.00 0.00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: **RBS Greenwich Capital**

**Hedging MBS Optionality**

A mortgage investor is short calls to the borrowers whose mortgages back their investment. In options terms, the mortgage investor is short both gamma (short expiry options) and Vega (long expiry options). Most investors
measure MBS exposure to volatility by examining option-adjusted convexity\(^{48}\) (OAC) and Vega (price change for a 1% increase in Black volatility).

### Figure 50: Selected MBS, Vega and Convexity Exposure

<table>
<thead>
<tr>
<th>Security</th>
<th>Coupon</th>
<th>Price</th>
<th>OAD</th>
<th>Vega</th>
<th>Convexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>FNMA 30Y</td>
<td>5%</td>
<td>96-08</td>
<td>5.00</td>
<td>-0.23</td>
<td>-1.72</td>
</tr>
<tr>
<td></td>
<td>6%</td>
<td>100-16+</td>
<td>2.67</td>
<td>-0.21</td>
<td>-2.61</td>
</tr>
<tr>
<td></td>
<td>7%</td>
<td>103-00</td>
<td>1.38</td>
<td>-0.12</td>
<td>-1.40</td>
</tr>
<tr>
<td></td>
<td>8%</td>
<td>103-16</td>
<td>1.83</td>
<td>-0.09</td>
<td>-0.62</td>
</tr>
<tr>
<td>FNMA 15Y</td>
<td>5%</td>
<td>98-08</td>
<td>3.49</td>
<td>-0.12</td>
<td>-1.22</td>
</tr>
<tr>
<td></td>
<td>6%</td>
<td>101-15</td>
<td>2.25</td>
<td>-0.12</td>
<td>-1.73</td>
</tr>
<tr>
<td></td>
<td>7%</td>
<td>102-08</td>
<td>1.69</td>
<td>-0.04</td>
<td>-0.63</td>
</tr>
</tbody>
</table>

Note: Vega defined as price change for a 1% parallel shift upwards in implied volatility.

Source: RBS Greenwich Capital

**Hedging Yield Curve Exposure in MBS**

In addition to selecting the correct duration, investors must also grapple with yield curve exposure. Since mortgages are amortizing assets and subject to prepayments, principal cash flows are distributed from the month after settlement out until maturity, typically thirty years for a mortgage pass-through. Figure 51 shows the expected cash flows for a conventional 6% (near par at press time) mortgage over its life using a 200% PSA prepayment assumption (equivalent to 12% CPR once the seasoning ramp is finished). Theoretically, we should hedge each month’s cash flow with a zero-coupon bond or a strip of Eurodollar futures, but in practice, we can achieve minimal tracking error by using 2 to 4 coupon bonds or standard interest rate swaps to hedge the duration and yield curve risk of MBS.

### Figure 51: FNMA 6 principal cash flows (annually) at 200% PSA

The 30-year part of the yield curve is an important hedge component for discount pass-throughs. While many traders and investors ignore this fact, it leaves them open to significant tracking error in the event of a 10s-30s realignment in Treasuries or swaps. The following table (Figure 52) examines the duration bucket exposure of selected pass-through coupons across the yield curve as of publication. These exposures change constantly as the market moves.

\(^{48}\) Often termed “negative convexity” by mortgage market participants, because convexity usually is negative for MBS.
Figure 52: MBS hedge ratios vs. US Treasuries (for $100 million par amount MBS) – Example Only, Not up to Date

<table>
<thead>
<tr>
<th>Coupon</th>
<th>2Y</th>
<th>5Y</th>
<th>10Y</th>
<th>30Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>FNMA 30Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5%</td>
<td>43</td>
<td>32</td>
<td>27</td>
<td>3</td>
</tr>
<tr>
<td>6%</td>
<td>50</td>
<td>21</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>7%</td>
<td>49</td>
<td>14</td>
<td>-2</td>
<td>0</td>
</tr>
<tr>
<td>GNMA 30Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5%</td>
<td>46</td>
<td>32</td>
<td>27</td>
<td>3</td>
</tr>
<tr>
<td>6%</td>
<td>54</td>
<td>21</td>
<td>7</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: RBS Greenwich Capital

CMO Hedging and the Yield Curve

For most standard CMO tranches, a single point on the yield curve is a reasonable hedge. However, wide window bonds may require hedging of multiple points along the yield curve, similar to hedging the underlying collateral. Figure 53 shows how the bulk of duration risk may be in a single point for a specific bond, but hedging multiple points would help reduce yield curve risk. Note how only 55% of the hedging of this sequential is in the 10Y area, the rest is spread among the 2Y, 5Y, and 30Y points on the yield curve.

Figure 53: Partial durations of a 5Y wide-window sequential

<table>
<thead>
<tr>
<th>Yield Curve Point</th>
<th>2Y</th>
<th>5Y</th>
<th>10Y</th>
<th>30Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partial Duration</td>
<td>0.6</td>
<td>1.5</td>
<td>2.7</td>
<td>0.1</td>
</tr>
<tr>
<td>Percent of hedge</td>
<td>12%</td>
<td>30%</td>
<td>55%</td>
<td>3%</td>
</tr>
<tr>
<td>OAD</td>
<td>4.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: RBS Greenwich Capital

Differences When Hedging CMOs

Hedging CMOs is art as well as science. Very short CMOs may best be hedged with interest rate swaps, Eurodollar strips, or short UST. Intermediate tranches could use only underlying collateral to hedge, or perhaps a combination of UST or swaps and a collateral hedge. Perhaps an investor could have a core collateral short, then check partial durations and reduce yield curve risk by executing some additional hedges in swaps, UST, or Eurodollars.

Hedging Cap Risk in Floaters

Cap risk is a significant issue for CMO floater buyers. The OAD of a floater climbs as the cap gets closer to the money, as a floater with a coupon that is capped has become a fixed rate bond with only downside in terms of its coupon. A bond with a well-defined cash flow can be easily uncapped by purchasing caps or caplets at the same LIBOR strike. Many investors prefer to reduce the cost of uncapping a floater by purchasing cap corridors in the OTC market (e.g. buying a cap at one rate, say 7%, to uncap the floater, then selling a cap at a higher rate, say 10%, to recoup some of the cost of the lower cap). The investor starts to run into hedging issues on bonds with more variable cash flows – the length of the cap required becomes unclear. Purchasing a cap with a term that is too long is expensive up front, and if the market rallies, the bond being hedged will probably prepay quickly, eliminating the need for protection, at the same time as the value of the OTC cap is declining.

To Hedge or Not to Hedge...

Frankly, many investors and traders never try to hedge out gamma and vega exposures in the mortgage market or cap risk in floaters. Much of the time, an investor would pay more to buy back the options they have implicitly sold in a mortgage-backed security, setting up a negative arbitrage. Implied volatility typically trades higher than recent actual volatility, as shown in Figure 54. Most investors are willing to accept negative convexity and exposure to rising volatility in return for a higher yield on their MBS.
Investors who do try to hedge their options exposure can take many approaches. One example is to use an cancelable, amortizing swap to mimic the cash flows of the mortgage. Another is to try to match the delta, gamma and vega exposure of the MBS.

**Figure 54: Ratio of 3-month implied vs. 3-month historical volatility on 10-year swaps**

![Graph showing ratio of implied vs. historical volatility on 10-year swaps from January 2005 to March 2007.](source: RBS Greenwich Capital)

**Examining VAR**

Value-at-risk (VAR) models look at a portfolio and try to identify “normal” profit and loss numbers for a time period (a day, a week, a year), but also what the profit or loss would be for an unusual event (say, 5% probability) or an extreme event (1% probability). Investors can examine historic trading patterns of MBS to help determine their level of risk in the current market. For example, if an investor is long the mortgage-Treasury basis in the current coupon, the standard deviation of daily VAR is currently only 0.09% of the mortgage investment per day. However, history shows us that performance is not truly distributed in a normal fashion. Events can occur which result in returns that are many multiples of a daily standard VAR. For more reading on hedging mortgages, please see the Appendix entitled “A Convexity Hedging Primer”.

**Chapter 15: Beating the Mortgage Index**

**Index Components**

The mortgage index (depending on provider) is made up of pass-throughs weighted by the amounts of current face outstanding in the market. All fixed-rate 30Y and 15Y FNMA, FHLMC, and GNMA I pass throughs are included. Indices may include other items, such as GNMA IIs or 20-year mortgages, depending on provider. Indices may also include hybrid ARMs, which have fixed-rates for a period of time. We show current index weightings of sectors and coupons, and a snapshot of our sector recommendations as of press time (see Figure).

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49 We believe that even the standard concept of a “fat tails” distribution is not enough to explain potential VAR. A better solution for determining extreme VARs is to look at historical VAR during periods of crisis, such as the 1998 Russian debt crisis or 9/11/2001.
**Figure 55: Index Weightings and Our Sample Recommended Asset Allocation to Beat the Index**

<table>
<thead>
<tr>
<th>MAX UNDERWEIGHT</th>
<th>UNDERWEIGHT</th>
<th>MODEST UNDERWEIGHT</th>
<th>NEUTRAL</th>
<th>MODEST OVERWEIGHT</th>
<th>OVERWEIGHT</th>
<th>MAX OVERWEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>(100%) Pass Throughs vs. UST</td>
<td>Pass Throughs vs. Swaps</td>
<td>Pass Throughs vs. Vol</td>
<td>(67%) Conventional 30Y</td>
<td>(2%) 4.5</td>
<td>(18%) 5.0</td>
<td>(25%) 5.5</td>
</tr>
<tr>
<td>(17%) Conventional 15Y</td>
<td>(2%) 4.0</td>
<td>(6%) 4.5</td>
<td>(6%) 5.0</td>
<td>(3%) 5.5</td>
<td>(2%) &gt;= 6.0</td>
<td></td>
</tr>
<tr>
<td>(6%) GNMA I 30Y</td>
<td>(1%) 5.0</td>
<td>(1%) 5.5</td>
<td>(1%) 6.0</td>
<td>(1%) &gt;= 6.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(10%) Agency Hybrid ARMs</td>
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Note: percentages are outstanding amounts in aggregate MBS index, may not add to 100% due to rounding.

Source: RBS Greenwich Capital

**Overweight/Underweight**

One way that investors try to outperform the index is to overweight the sector when they believe it is cheap, typically selling UST or agency debt against MBS, and underweight it when they think it is rich, perhaps buying a different spread product. Since this is one of the higher VAR trades in MBS, this tends to be a large source of outperformance (Alpha) for many investors. Historical studies suggest that investors should be biased towards “positive carry” trades, so when MBS are positive carry versus their hedges, investors should err on the side of being overweight MBS, and only be underweight MBS when they are extremely rich.

**Coupon Swaps**

As we covered earlier in this paper, many investors overweight or underweight specific coupons for a number of reasons to make money. For example:

- Pick up carry.
- An historical relative value basis.
- To implement a macro view (yield curve, changing volatility)

**Dollar Rolling and Reinvesting**

One of the key tenets to investment management is to be able to maximize excess return (Alpha) while keeping your tracking error low (a Beta close to 1.0). One of the best ways to do this in MBS is to find securities that are financing well in the dollar roll market, and make sure to have at least an index weighting in those securities, no matter how rich they appear. Then, the investor dollar rolls those securities, and picks up that income (which is not reflected in index returns). This effectively adds alpha to the portfolio and keeps the beta at 1.0. It is tempting to underweight securities that are dollar rolling well and look expensive, but by underweighting those securities, an investor takes the risk that rich securities get richer, underperforming the index and taking tracking error, and also forgoes the dollar roll income on those securities.
Specified Pools

Seasoned pools (also called “WALA bonds”) are priced and included in most major mortgage indices. Investing in them helps an investor track the index more closely. It is of course possible to overweight or underweight these subsectors of the market. We tend to like specified pools when they are trading below 50% of their theoretical value, and dislike them when they are over 75% of their theoretical value, because at that point, it makes more sense to buy TBAs and have the potential advantage of dollar rolling bonds. There are also specified pools which are not in the index, such as

Hybrid ARMs vs. Fixed-Rate Investments

Hybrid ARMs have very different characteristics than fixed-rate pass-throughs. In general, hybrid ARMs of similar coupons have:

- Shorter OAD (duration)
- Less exposure to rising volatility.
- More exposure to the short end of the yield curve, rather than the long end.
- Less negative convexity (gamma).
- Slightly less liquidity.

In a recent paper, *Hybrid ARM vs. Fixed Rate MBS Relative Value Methodology*, we discuss methods of trading among different ARMs and fixed-rate bonds and find this strategy profitable, even when including transaction costs. For more information, please refer to the paper on our web site, under the White Papers section, at [http://www.rbsgc.com/Tools/Content/OpenItem.aspx?id=1039101](http://www.rbsgc.com/Tools/Content/OpenItem.aspx?id=1039101).

Outside-of-Index Investments

Investors also look at investments outside of the mortgage index. For example, some popular investments are:

- Non-agency fixed-rate MBS.
- Non-agency ARMs.
- Fixed-rate CMBS

Each has its own trade offs in terms of liquidity, convexity, etc.

Conclusion and Further Reading

You will also increase your knowledge of the mortgage markets if you follow regular commentary on mortgages, such as in the RBS Greenwich Capital *MBS Weekly*. RBS Greenwich Capital also provides an MBS Daily via email available to all investors.

Beyond reading regular mortgage commentary, there are a number of other books on the topic, such as the *Handbook of Mortgage-Backed Securities*, Frank Fabozzi, editor. One topic that is important, and covered in detail, is mortgage prepayment models and forecasting techniques. These types of books also deal with many topics, such as mortgage derivatives, in detail, but those are not necessary reading for the average mortgage pass-through or CMO investor.

The benefits of mortgages certainly outweigh potential risks for most investors: high yield, ability to short volatility, and credit safety. On the flip side, hedging of negative convexity and complex settlement procedures make MBS more difficult to invest in than US Treasuries. As MBS continue to grow in the US, they are also becoming a larger part of investor portfolios around the globe.
Appendix A: Glossary

**Accretion** is the process of adding interest to principal owed to the investor instead of paying a coupon to the investor as the interest becomes due. Accretion allows the creation of temporary “zero coupon” bonds, known as Z bonds in the CMO universe. During an accretion period, a Z-bonds factor will rise each month.

**Actual delay days.** Defined as delay days – 31 days. The number of days a principal and interest payment is actually delayed before the investor receives it.

**Agency.** While technically, GNMA is the only government agency in the MBS market, this term is typically used to refer collectively to FNMA, FHLMC, GNMA, and sometimes the FHLBs. Technically, FNMA and FHLMC are not agencies, but Government Sponsored Enterprises (GSEs). GNMA has the explicit full faith and credit of the US Government backing it and its securities. The GSEs do not.

**Alternative A, or Alt-A.** These are whole loans that do not quite qualify as prime credit, but are still considered a low default risk. Either the borrower has a minor credit blemish or he simply lacks enough of a U.S. credit history. FNMA and FHLMC may securitize some of this type of loan for a higher guarantee fee than for prime loans.

**Alternative B, or Alt-B.** Slightly worse than Alt-A loans, they typically have a FICO score below 650 or a rate 50 bp or more above the prime quality mortgage lending rate. In some ways, these loans may be hard to distinguish from subprime loans.

**Amortization schedule.** Many CMOs have designated amortization schedules which they try to adhere to. For example, PACs and sinkers. This is very similar to a sinking fund schedule for corporate bonds.

**Anti-sinker.** A sinker and anti-sinker are created by splitting a standard CMO tranche, such as a sequential. The sinker class is generally more stable, and the anti-sinker has more cash flow variability in return for a higher yield. An anti-sinker is still more stable than a typical companion bond on a PAC deal.

**Average life** is the dollar-weighted average time return of investment principal to the investor. Some market participants compare MBS to Treasury bonds with a similar maturity to the MBS average life. However, *Option Adjusted Duration (OAD)* is a better way to measure of interest rate risk and hedge. CMO spreads to Treasuries are typically quoted by using average life, often using the “I”, or interpolated, Treasury curve and the median projected prepayment speed.

**Burnout** refers to the decline of prepayment speeds after the initial peak of prepayments, as the most rate-sensitive borrowers refinance out of a mortgage pool, leaving less rate-sensitive borrowers.

**CMO, or collateralized mortgage obligation,** is a structured mortgage-backed security, often in REMIC form. Mortgage pass-throughs are placed in a trust and used as collateral to issue various securities (the CMO tranches) out of the trust, dividing up the underlying principal and interest cash flows among different tranches.

**Cohort.** All the pass-through pools from a certain agency, with a specific coupon and issue year, form a cohort (e.g. 2007 production FHLMC Gold 5.5s). Cohorts are often used for prepayment reporting or comparison purposes.

**Collateral** technically refers to the pass-throughs or other bonds (e.g., other CMOs) backing a structured deal, such as a mortgage CMO. In practice, many market participants use the term “collateral” to mean mortgage pass-throughs.

**Companion, or support bond.** A companion bond is structured to absorb a deal’s cash flow volatility in a PAC or similar CMO deal. When there is excess principal that PACs are not scheduled to receive, the front companion bond’s principal is paid off. Or, if the PACs need all available principal payments, the companion bond(s) receive no principal for that month, potentially until all PACs are paid off. This structure makes companion bond average lives highly variable as interest rates move. Companions have more negative convexity than underlying collateral in return for higher yields.

**Compensating interest** may be paid by the servicer, originator or deal sponsor in a non-agency CMO deal to make up the interest income shortfall due to individual loan prepayments before the end of the month. The
agencies\textsuperscript{50} pay full compensating interest on their pass-throughs. Apart from the agencies, compensating interest payments are usually capped in some way, creating risk to investors in high prepayment environments.

**Conforming loans.** Congress sets the conforming loan limit for FNMA and FHLMC loans each year ($417,000 for a one family home in 2007). Fannie Mae and Freddie Mac may not purchase or securitize single-family mortgage loans above this limit. Those are called Jumbo mortgages. Conforming loans must also match other Fannie Mae and Freddie Mac specifications for loan documentation, job history, credit information, debt-to-income ratios, etc. Note that the Federal Home Loan Banks are allowed to buy Jumbo loans. Fannie Mae and Freddie Mac can buy some non-conforming loans, such as Alt-A or sub-prime, but balances must still be below the conforming limit.

**Conventional vs. government loans.** Conventional loans are originated by private lenders (including banks and standalone mortgage originators) for the mortgage market. Conventional loans are typically \textit{conforming} and not guaranteed by any government entity. Government loans are made by U.S. agencies such as the Federal Housing Administration (FHA) or Veteran’s Administration (VA) through approved agents and lenders. These government loans typically get securitized into GNMA\textsubscript{s}, but can be bought as whole loans or be securitized by the GSEs.

**Convexity.** Convexity is the rate of change of duration for a given move in interest rates. Mortgages typically have negative convexity, similar to a callable corporate bond, and have more price downside than upside potential when starting at par. Intuitively, convexity is a measure of how much a bond’s price increase in a market rally exceeds its decrease in an identical but opposite sell-off. Mortgages have negative convexity because of the borrower’s option to prepay the loan when interest rates decline.

**CPR**, or conditional prepayment rate, is an annualized measure of prepayments for a specific time period. For example, 10% CPR for the past month means that 10% (annualized) of a mortgage pool’s principal paid off, over and above the scheduled principal paid that month. The term is also used when projecting prepayments going forward.

**Current coupon.** The pass-through security closest to par ($100-00) is often termed the “current coupon”, and the 30Y mortgage is most typical. Many new pass-throughs are typically issued with the current coupon. The current coupon rate is a synthetic secondary-market mortgage rate calculated using a weighted average of the two mortgage coupons surrounding par.

**Delay days.** The amount of time between the start of interest accrual for a month (typically the first day) and the date the investor actually receives the interest payment in arrears. Equivalent to \textit{stated delay}.

**Dollar roll.** This refers to the simultaneous sale and repurchase of a mortgage pass-through for different settlement dates, typically at different prices, effectively financing the pass-through.

**DTC, or Depository Trust & Clearing Corporation.** The DTC is the clearing house through which CMOs are settled electronically. The DTC, through its subsidiaries, provides clearance, settlement and information services for other products, including equities, corporate, municipal, and emerging market bonds.\textsuperscript{51}

**Duration** is the dollar-weighted average time of the payment of principal \textit{and} interest to the investor (\textit{average life} only takes principal into account). For a standard, bullet maturity bond like a UST, the duration of the security is a close approximation of its price sensitivity to a change in interest rates. For MBS, option-adjusted duration (OAD) is significantly more accurate.

**Expected final maturity** is the day the investor expects to receive the last cash flow from a pass-through or CMO.

**Factor.** Initially set at 1.0 for a CMO tranche or pass-through pool, it reflects the amount of bonds remaining as a fraction of the original balance. Note that a factor can increase to over 1.0 if interest is deferred and added to the principal owed to the investor, a process called \textit{accretion}.

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\textsuperscript{50} GNMA, FNMA, and FHLMC securities all pay compensating interest without a cap.

\textsuperscript{51} From DTCC’s web site.
FAS 115: Accounting for Certain Investments in Debt and Equity Securities. This statement sets up the framework of “held-to-maturity”, “trading account”, and “available for sale” investment categories. Note that investments in “available for sale” do not see their profit and loss hit the income statement each quarter, but only when they are sold or transferred to the trading account.

FAS 133: Accounting for Derivative Instruments and Hedging Activities. This statement effectively required OTC derivatives to be marked to market at fair value and moved through the income statement on a quarterly basis on the balance sheet. A blanket exception was made for derivatives embedded in MBS.

FAS 155: Accounting for Certain Hybrid Financial Instruments. FAS 155 requires embedded derivatives (including MBS) to be broken out separately and marked to market. Alternatively, the entire instrument can be marked to market. Exceptions are callable bonds and the prepayment option embedded in standard pass-throughs, IOs, POs, and CMOs.

FAS 156: Accounting for Servicing of Financial Assets – an amendment of FASB Statement no. 140. This updates how servicers account for MSR.

FAS 157: Fair Value Measurements. This statement provides guidance on how to measure assets and liabilities at fair value. It must be adopted by corporations adopting FAS 159.

FAS 159: The Fair Value Option for Financial Assets and Financial Liabilities – Including an amendment of FASB Statement no. 115. This statement allows institutions to select financial assets and liabilities on a line-by-line basis to mark to market going forward. There is a one-time opportunity on adoption to reclassify assets from HTM or AFS into the trading account.

Government Sponsored Enterprise, or GSE. This term refers to institutions set up by the government but now run as private corporations, such as Fannie Mae and Freddie Mac. See agency for a comparison.

Gross WAC. Also known as the gross coupon, this is the balance-weighted average coupon (“WAC”) of an MBS’s underlying loans.

Guarantee fee. The agencies generally charge a 10 to 20 bp annual fee (deducted from the gross coupon) in order to wrap, guarantee, and assign a pool number to a pool of mortgage loans. This fee is charged each month on the current balance of a pool of pass-throughs before principal payments are deducted.

Inverse floater. A bond where the coupon moves inversely to a market index, typically one-month LIBOR, but any index is possible. These types of bonds typically have OADs much longer than the underlying cash flow.

IO, or Interest Only, strip refers to a security receiving only the interest portion of cash flows from a specific pool of collateral. The most liquid IOs are Trust IOs, with their own identifying number. The principal portion, or PO, can be sold separately. Excess servicing deals do not have a corresponding PO tranche.

IOette is similar to an IO, but is stripped off of a tranche, tranches, or all the collateral from a CMO deal. It may be an even strip, effectively equivalent to a trust IO, or it may be much more complicated in structure. IOettes can have a small amount of actual principal, giving them very high dollar prices, or no principal, in which case they trade at very low prices with a notional principal.

Jumbo. A jumbo loan’s balance by definition exceeds the conforming loan limit for Fannie Mae and Freddie Mac. Dealers or originators typically securitize jumbo loans off their own issuance shelves (special purpose vehicles created to hold and securitize loans). Note that the FHLBs are allowed to purchase jumbo loans or securities backed by them, but Fannie Mae and Freddie Mac cannot.

Legal final maturity is the last possible day an investor could receive the last cash flow from an MBS, the date set at the security’s inception (assuming no prepayments). The expected final maturity of most CMOs is significantly earlier than the legal final maturity.

Lockout. The period of time before a regular CMO starts receiving principal under a given prepayment scenario. The time a CMO tranche is “locked out” depends on a deal’s structure and ultimately, future prepayment speeds experienced by the underlying collateral.
Mega/Giant/Platinum pool. These terms all refer to a “pool of pass-through pools.” GNMA and the GSEs charge a small fee to facilitate creation of these pools. These new pools consolidate small balance pools, simplify record keeping and reduce custodial fees. Investors or dealers may create these pools for a fee. Note that mega/giant/platinum pools are not included for the purposes of calculating issuance and prepayment statistics, as that would be double counting.

Net WAC. Also known as the net coupon, net WAC is the stated interest rate available to investors after mortgage servicing and guarantee fees are deducted from the gross WAC. Net coupons in pass-throughs are almost always integer and half coupons (e.g. 6%, 6.5%, 7%). Some quarter coupons exist but these tend to be illiquid.

Non-agency mortgages. These single-family loans typically comprise either Jumbos or loans not securitized by Fannie Mae and Freddie Mac for other reasons. They are often securitized into CMOs or AAA pass-throughs, but may also be traded as whole loans.

Notional principal. When an Interest Only (IO) tranche is structured without any principal, the amount of principal it was stripped from is called the “notional principal” and is used to calculate the factor for the IO tranche. Interest for the IO is paid on the remaining notional principal at the start of the month it accrues.

Option-adjusted duration (OAD). Most prime US mortgages can be prepaid at par at any time without penalty. Thus, a de facto call option held by the borrower is “embedded” in the mortgage itself. Because of these embedded options in MBS, OAD is often different from a standard duration measure, such as modified duration. OAD is typically a better representation of a security’s interest rate sensitivity than modified duration, average life, or other static measures.

Option-adjusted spread (OAS). OAS estimates the average spread that a security is expected to yield over a benchmark yield curve (say, Treasuries or interest rate swaps) and a range of possible interest rate scenarios. It effectively values the embedded options in callable securities, such as MBS or callable agency bonds, and deducts the embedded option cost from the nominal spread calculated using the forward yield curve. (See LIBOR OAS.)

PAC or Planned Amortization Class (Type I PAC, or PAC 1). A PAC bond is designed to mimic a corporate bond’s structure as closely as possible by setting out an amortization schedule that targets a certain average life, much like a corporate bond’s maturity date. The PAC bond may in fact pay faster or slower than its amortization schedule, depending on actual prepayment experience and the CMO deal’s particular structure.

PAC 2 (Type II PAC). A PAC 2 is structured with an amortization schedule, just like a PAC 1, but its cash flow priority is below the Type I PACs in the deal, but above companion bonds. If the companion bonds are all retired, the PAC 2s effectively become the new companion bonds, protecting the PAC 1 bonds.

PAC band. PAC bonds are designed to adhere to their amortization schedule, as long as prepayments remain within a specified range for the life of the security, the PAC band (e.g. 100 – 250 PSA). If prepayments are higher or lower than the band for long enough, the bond could deviate from its amortization schedule and lengthen or shorten versus its scheduled average life. The effective PAC band changes over the life of the security based on the collateral prepayments experienced, a phenomenon known as PAC band drift.

PACquential. Similar to a PAC bond, but with the lower end of the PAC band at a higher prepayment speed than usual for a PAC (e.g. 150 PSA instead of 100 PSA), thus the PACquential has more extension risk. This feature makes a PACquential look similar to a combination of a PAC and a sequential.

Parity price. The price for a bond where it has the same yield, regardless of prepayment speed. For example, for pass throughs, the parity price is typically between $99-00 and $100-00, rather than $100-00 flat, because of the stated delay of cash flows built into the pass-through structure, which reduces the value of the coupon and principal retrieved.

Pass-through can refer to an agency or non-agency mortgage-backed security with a simple structure. Mortgage principal and interest payments are passed through directly to investors with a specified number of days of actual delay, after mortgage servicing and FNMA, FHLMC, or GNMA guarantee fees are deducted.
Multiple investors can own a dollar amount of the same pass-through, each receiving a pro-rata share of principal and interest each month.

**Payer.** A bond which is currently paying interest. For example, a Z bond will typically accrete interest at the start of its life52, increasing its factor over the initial 1.0. At some point, the Z bond stops accreting interest and begins to pay interest and principal to the Z bond investor. It is then called a payer. Any regular CMO tranche currently paying interest to the investor can also be called a payer.

**PO (Principal Only) “strip”** refers to a security receiving only the principal portion of a pool of collateral or from a CMO, the counterpart to an IO. POs typically have very long durations, because higher interest rates can slow prepayments and dramatically decrease the value of the PO by drawing the return of principal over a long period of time. POs themselves can be further structured into super POs, PAC POs, etc.

**Pool.** Each pass-through security guaranteed by GNMA and the GSEs is given a pool number, as well as a CUSIP. All data reporting by the agencies, such as for prepayments, is done by pool. Multiple pools may make up collateral for a CMO transaction.

**Pool factor.** This represents the portion of the original balance remaining in a pool. Even without prepayments, the pool factor can decline each month as scheduled principal payments pay down loan balances. Most TBA trades are done on a “current face” basis, meaning based on the current amount outstanding of bonds delivered. To calculate current face, the original face amount of the bonds is multiplied times the pool factor. Trades for specified pools are often done on “original face” because the pool factor for future settlement may not be known yet.

**Prepayment.** This is principal returned to the investor because of refinancing, moving, recovery from default, or any reason other than a scheduled principal repayment. Also referred to as unscheduled principal. Note that a prepayment may be in full or only for part of the loan (known as curtailment, because a partial prepayment effectively shortens the maturity of the mortgage).

**Prepayment speed.** Using a specified measure, such as annualized prepayments, prepayment speeds are reported historically or projected for a pool, cohort, or other MBS.

**PSA,** or prepayment standard assumption, is a convention for expressing mortgage prepayments that is heavily used to price CMO deals. The PSA curve uses the age of the underlying mortgages (WALA) to assign a CPR speed. At 100% PSA, for the first 30 months, loans are assumed to “ramp” up linearly from 0% CPR (at 0 months of age) to 6% CPR. Once loans are 30 months old, they are assumed to be fully seasoned using this assumption and at that point, 100% PSA is equivalent to 6% CPR.

**REMIC (real estate mortgage investment conduit).** REMIC is a tax election for a securitized deal that allows creation of structured deals, including CMOs, with various benefits to the investor. These benefits include exemption from taxation at the trust level (avoiding double taxation).

**Residual.** The equity portion of a CMO or other securitized asset deal. Note that agency and non-agency CMO deals no longer have so-called economic residuals, which have deal cash flows associated with them. So-called non-economic residuals potentially have tax liabilities, and so dealers must pay investors to take them. They initially have phantom income, followed by expenses. Thus, residuals typically have tax implications for the holder and are typically traded on a physical certificate basis (i.e., they cannot be settled electronically via DTC like CMO bonds can). Note that sometimes the issuer retains the residual. There are restrictions on non-domestic holding of residuals.

**Scheduled principal.** Fully amortizing mortgages pay both interest and scheduled principal each month in order to retire the entire principal balance by its maturity date. Note that “interest first” or “IO” mortgages do not pay scheduled principal initially, but start after the “IO” period is over.

**Sequential.** A sequential CMO deal typically takes the expected principal cash flows from a pool of collateral and “time tranches” it into multiple tranches. The first sequential tranche typically receives scheduled and unscheduled principal from the collateral until the tranche is retired, then the next sequential in line starts...

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52 That is, not pay coupon interest immediately, but defer it until later.
receiving principal, etc. until all the sequentials are paid off. The deal may become more complicated with the addition of NAS bonds or other higher priority tranches.

Servicer. The servicer bills mortgagors, collects mortgage payments and forwards them to investors (or their trustee) in return for earning a servicing fee and ancillary benefits. The servicer is required to advance mortgage payments on a timely basis (so long as it deems payments recoverable), but the servicer also keeps float on the timely payments and any late fee income. The servicer may also collect money in escrow to pay property tax and/or home insurance premiums.

Servicing fee. The servicer collects a fee from the interest portion of the mortgages. The fee is generally between 12.5 and 80 bp annually. Minimum servicing is generally 12.5 bp on non-agency deals and 25 bp on agency pass-throughs. (See servicer.)

Sinker. A bond with a predetermined “sinking fund” schedule, similar to a PAC bond, but without a PAC band. These bonds are typically split off short sequentials, providing excellent extension protection for a give-up in spread versus a short sequential.

Support. Another name for companion bond. It typically refers to the remaining cash flow in a PAC deal, but can also be used more generally for other cash flows, such as an anti-sinker.

TAC, or targeted amortization class, generally has call protection below a certain prepayment speed (PSA) target, but not much extension protection. The call protection is similar in nature to a PAC bond’s.

TBA, or “to be assigned”, refers to pass-through trades where an agency, maturity, and coupon are specified, but actual pool numbers (and hence CUSIPs) are not selected until two business days before settlement. Note that one TBA trade may involve many different securities.

Term structure model. A term structure model takes as inputs a yield curve (typically Treasury or swaps), a representation of volatility, and correlations between the two to model future interest rates. In one version, a Monte Carlo implementation, the model will run many different, random interest rate scenarios governed by the model and its inputs. When evaluating MBS, an OAS model will average the results over the different paths of interest rates generated by the term structure model. Variance reduction techniques can be used to optimize the number of paths run.

Tranche. This term refers to a single bond (with one CUSIP) within a CMO or ABS deal.

Vanilla or plain vanilla. Another name used for sequential.

Waterfall. A waterfall refers to the deterministic rules governing distribution of principal and interest in a CMO or ABS transaction.

WAM/WALA. Weighted average maturity (WAM) and weighted average loan age (WALA) should be complements of each other. That is, a new 30-year mortgage pool will often have WAM+WALA = 30 years, or slightly less in the case of curtailments. WALA refers to the number of months the loans have aged since loan origination and WAM is the number of months remaining until maturity. As partial prepayments are received, the calculated maturity of the pool may be reduced, so WAM+WALA will be less than 30 years.

Whole loan refers to residential mortgages before they are securitized as a pass-throughs (i.e. the loans retain credit risk). Whole loan packages are traded on Wall Street, but are much less liquid and homogenous than agency pass-throughs.

Window. A bond’s window runs from the date it is first expected to receive principal to the date the bond is expected to retire at a certain prepayment speed. Please note that the window can change based on actual and projected prepayment speeds. Certain bonds can have the window open and close again under certain prepayment environments.

Z bond. In the case of a Z bond, interest accrues initially and is added to principal (accretion). The Z starts to pay down interest and principal (called becoming a payer) based on deal structure and prepayments. A Z bond can be created from any of the fundamental cash flows, such as a sequential or PAC.
Appendix B: Useful Bloomberg Commands

Pulling up a CMO

A CMO can be pulled up via a Bloomberg ticker, a CUSIP identifier, or a temporary ticker assigned by a dealer. The Bloomberg ticker is generally FNR or FHR (for Fannie Mae or Freddie Mac REMIC), followed by a space, the deal number, another space, the tranche letter(s), and the mortgage key. e.g. FNR 07-42 YP <Mtge>. This ticker must be followed hitting the <Go> button to pull the bond up, then a command may be issued from the list below. Please note that most CMO prices in Bloomberg are inaccurate, although live pass-through and recent closing IO strip prices should be reasonable.

Alphabetical list of some useful Bloomberg commands for CMOs

All of the following commands can be executed after pulling up a CMO in Bloomberg. Simply type the command and hit the <Go> key. Please note that we do not recommend using OAS functions on Bloomberg, as the term structure and prepayment models available are not state-of-the-art. Bloomberg is more useful for examining tranche types, getting Bloomberg street median prepayment forecasts, and calculating yield tables or pricing out a tranche for purchase or sale.

CAMP – New and outstanding CMOs, total
CAV – Collateral availability
CFT – Cash flow table
CLASS – Description of class types
CLC – Collateral composition
CMOR – Displays recent CMO deals
DES – Provides tranche description
DES2 – Provides CMO collateral description
FMED – Run the FFIEC test on a tranche (user must input correct bond price)
HPF – Historical prepayment forecasts
ICMO – Displays aggregated CMO issuance
SPA – Structure view
VAC – View all classes – allows the user to look at all the tranches in a deal
VALL – Dealer prepayment forecasts
VMED – View Bloomberg median prepayment speed
WALG – Weighted average life graph.
YT – Yield table
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