

## The Trust IO/PO Market

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- ▶ Interest-only (IO) and Principal-only (PO) mortgage-backed securities are created by stripping the interest and principal payments from Agency pass-throughs and distributing these payments to separate classes. This primer discusses some of the institutional aspects of the IO/PO market along with a detailed discussion of several issues related to the pricing of IOs and POs.
- ▶ IOs and POs allow investors to express a “leveraged” view on prepayments relative to the collateral because the cash flows of an IO or a PO are usually a lot more sensitive to prepayment projections than the cash flows of the underlying collateral. As a result, although the investment risks associated with IOs and POs are similar to those associated with pass-through securities, they are magnified manifold. We discuss the exposure of IO/PO prices to key risk factors such as interest rates, curve shape, prepayment model forecasts, mortgage spreads, and volatility.
- ▶ The two most commonly used relative value metrics for IOs and POs are yield and OAS. The well-documented shortcomings of yield as a measure of return for MBS are accentuated for IOs and POs because of the extreme sensitivity of these instruments to prepayment speeds. OAS is a much better metric but also possesses shortcomings because of the presence of significant prepayment risk in IOs. We illustrate some of the volatility present in IO OASs by walking through a historical case study.
- ▶ The unusual duration and convexity characteristics of IOs and POs make them appealing to a wide range of market participants with different investment motives. Investors can use these instruments to hedge prepayment or interest rate risk; to express views on interest rates, mortgage spreads and volatilities; to take advantage of any arbitrage opportunities vis-à-vis underlying collateral; to create desired investment or duration profiles; or to simply benefit from their attractive carry.
- ▶ The primer also contains three appendices. Appendix A describes some of the basic features of excess servicing IO-backed MBS. Appendix B provides a brief tutorial on the breakeven prepayment model. Estimating this model allows us to extract market expectations for prepayment speeds from IO/PO prices. Appendix C reviews the settlement convention for Trusts.

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## I. INTRODUCTION

The first mortgage-backed securities (MBS) simply “passed through” the principal and interest made by homeowners on their 30-year fixed-rate mortgages. However, the Wall Street investment banks making markets in these securities rapidly realized that a pass-through MBS backed by 30-year mortgages did not offer a diverse enough range of investment characteristics. Their solution was to use specific allocation rules to redistribute the principal and interest payments generated by the underlying mortgages and thus create bonds with risk profiles customized to be attractive to different types of investors. One of the very simplest types of redistributions resulted in the creation of the class of securities this primer will focus on: **Stripped Mortgage-backed Securities (SMBS)**. SMBS are created by separating (“stripping”) the interest and principal payments in a pass-through cash flow and then allocating specified percentages of these payments to separate classes. The most common SMBS structures are **Interest-Only (IO)** and **Principal-Only (PO)**. As the terminology suggests, an IO receives 100% of the interest cash-flows from the underlying pass-throughs and 0% of the principal. On the other hand, the PO receives both scheduled and unscheduled payments of principal and none of the interest. Other variations in how the principal and interest cash flows are allocated are common and we can create **synthetic** coupons by distributing the principal and interest cash flows unequally.<sup>1</sup> While our focus on synthetic structures is limited, this primer provides some examples of how these structures are created and used by investors in actual market practice.

For the time being, let’s defer the natural question of why IO or PO cash flows might be of interest to investors and study how these cash flows vary as a function of prepayment rates. This will give us some preliminary intuition on the risk profile of securities generating these cash flows. To this end, Figure 1 illustrates the distribution of pass-through cash flows over time at two different predetermined prepayment rates and separately labels the principal- (PO) and interest-only (IO) components of this cash flow. Focusing on the IO cash flows first, notice how “interest lives on the principal.” More precisely, the amount of interest payments received by IO holders depends both on the amount of principal outstanding and the amortization rate (scheduled and unscheduled) of this principal. The blue shaded area corresponds to the total amount of interest payments received and is clearly smaller at faster prepayment rates. We conclude that, all else being equal, faster prepayments will always hurt IO holders since they reduce the amount of cash flows received.

On the other hand, a PO cash flow holder will always get all of their principal back<sup>2</sup> with the return on the security depending upon the timing of these principal payments. Since a PO will always trade below par, all else being equal, the sooner the investor gets their money back (the faster the prepayment rate), the greater the return.

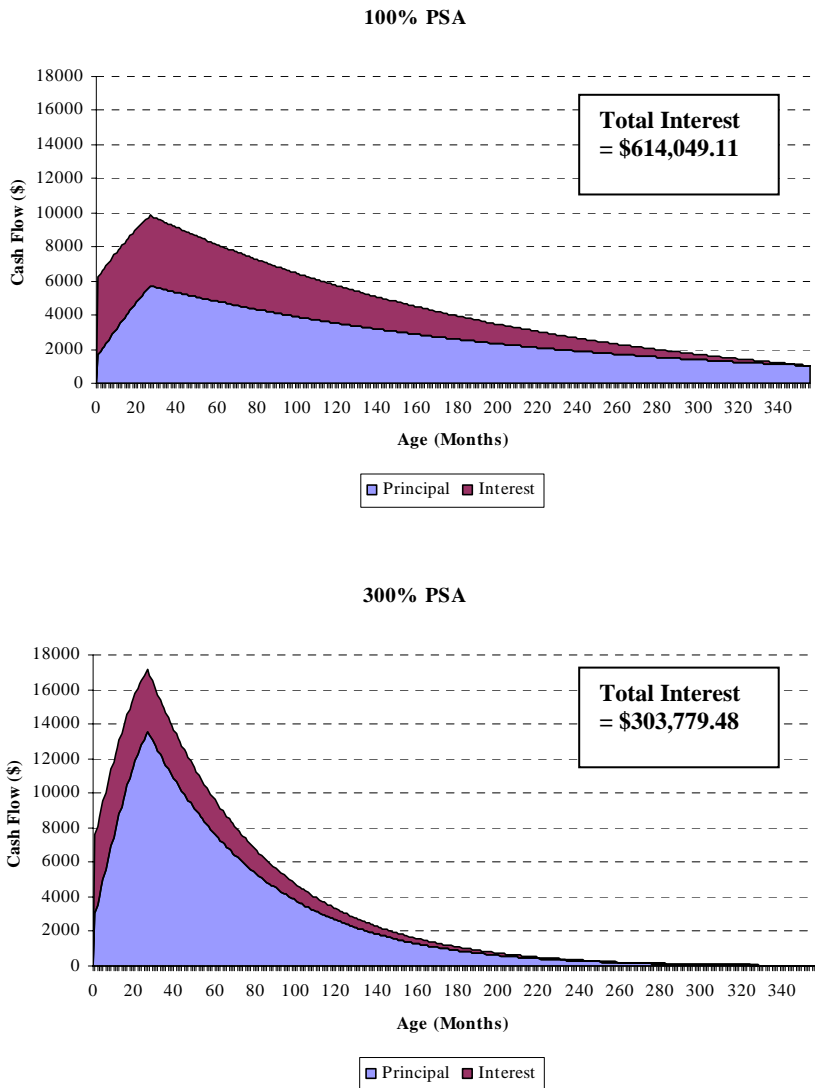
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<sup>1</sup> The securities that results from these unequal distributions are termed “synthetic” because they have a coupon rate that is different from that of the underlying collateral.

<sup>2</sup> Under the assumption that Agency pools have no default risk.

Summarizing, since faster prepayments are always bad for IOs, IOs can be thought of as the “ultimate premium security”. Similarly, on the other side of the coin, a security backed by principal cash flows on pass-through pools can be considered as the “ultimate discount security.”

**Figure 1: Interest and Principal Cash Flows on a 5.5% Pass-through as a Function of Prepayment Rates**



Beginning Balance = \$1mm.  
 Source: Banc of America Securities

Let’s return to the question we deflected earlier: why would somebody want to purchase a security with these characteristics? Even our simplistic analysis above should make it evident that market prices on IO/PO securities will be very sensitive to prepayment assumptions. Thus, these securities reflect an efficient way for mortgage market participants to express a view on the pricing of prepayment risk and also serve as vehicles for effectively hedging prepayment risk. Also, IOs are one of the few fixed

income securities with **negative duration**: IO prices increase as rates go up and prepayments go down.<sup>3</sup> Investors may thus find it convenient to hold these securities in their portfolio as a hedge for increasing rates. Similarly, POs respond favorably to increased prepayment risk and can be used as hedges for prepayment risk by institutions that are naturally long prepayment risk like mortgage servicers. As a result of these desirable characteristics, the Trust IO/PO market which consists of stripped IOs and POs which are structured into trusts is an active part of the securitized Agency mortgage market with an estimated outstanding volume of \$81bb.<sup>4</sup>

However, despite having an easily understandable cash flow profile, IOs and POs are some of the most challenging products to trade and price in the mortgage market. Their complexity arises from their high sensitivity to prepayment assumptions and leads to a fair amount of “idiosyncratic risk” associated with each security. In down to earth terms, this means that in buying an IO or PO class investors have to take a very close look at the characteristics of the underlying mortgages to see if they can gain any insight into factors that suggest this collection of homeowners might be predisposed to prepay faster or slower than the “average.” In particular, investors pay close attention to the distribution of servicers, loan sizes, loan ages, borrower mortgage rates and geographic location for the pool of mortgage loans backing the Trust.

In this primer, we delve into some of the details of this challenging and fascinating market. We begin by exploring how IO/PO structures are created and briefly discuss the secondary market in which these structures are traded. Central to understanding the price movements of these securities is understanding the risks associated with them and thus the next section discusses the exposure of IO/PO prices to key risk factors such as interest rates, curve shape, prepayment model forecasts, mortgage spreads, and volatility risk. The section after this addresses relative value, with the two most commonly used metrics for IOs and POs being yield and OAS. The well-documented shortcomings of yield as a measure of return for MBS are accentuated for IOs and POs because of the extreme sensitivity of these instruments to prepayment speeds. OAS is a much better metric but also possesses shortcomings because of the presence of significant prepayment risk in IOs. We also illustrate some of the volatility present in IO OASs by walking through a historical case study. The last section discusses some of the investments motives for market participants who trade IOs and POs. Investors can use these instruments to hedge prepayment or interest rate risk; to express views on interest rates, mortgage spreads and volatilities; to take advantage of any arbitrage opportunities vis-à-vis underlying collateral; to create desired investment or duration profiles; or to simply benefit from their attractive carry. We conclude with three appendices. Appendix A describes some of the basic features of excess servicing IO-backed MBS. Appendix B provides a brief tutorial on the breakeven prepayment model. Estimating this model provides us a way to extract market expectations for prepayment speeds from IO/PO prices. Appendix C reviews the settlement convention for Trusts.

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<sup>3</sup> We discuss this in detail later.

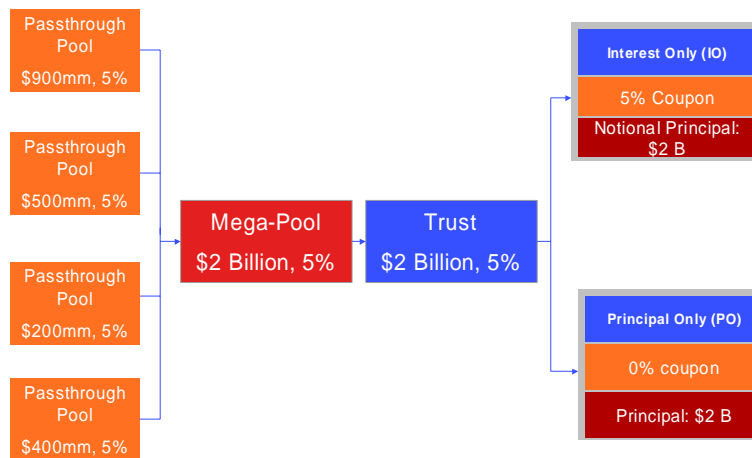
<sup>4</sup> As of October 2006.

## II. THE IO/PO MARKET

As we discussed above, **Stripped MBS (SMBS, “Strips”)** is the technical term used to refer to the securities containing IO/PO classes. Thus, whenever market participants speak of a “Trust IO” or a “Trust PO”, they are referring to a particular class associated with a specific SMBS. SMBS issued by Fannie Mae carry a FNS prefix, while those issued by Freddie Mac carry a FHS prefix. In general, market participants use the terms “Trust”, “IO/PO”, and “Strip” interchangeably.

Figure 2 walks through how SMBS are created in practice. In the first step, numerous pass-through pools are combined to create a mega-pool and the mega-pool certificate is then sold into a trust. The trust then issues an SMBS certificate with IO/PO classes similar to the ones illustrated in the figure. The SMBS will also typically issue additional classes that receive different portions of interest and principal. A crucial point to which we will return later is that the IO/PO classes can and often are exchanged for the underlying pass-through certificates backing the trust based on certain conditions and fees. They may also be exchanged for the other classes issued by the SMBS but this takes place much less frequently.

**Figure 2: Creating a Stripped MBS from Pass-through Pools**



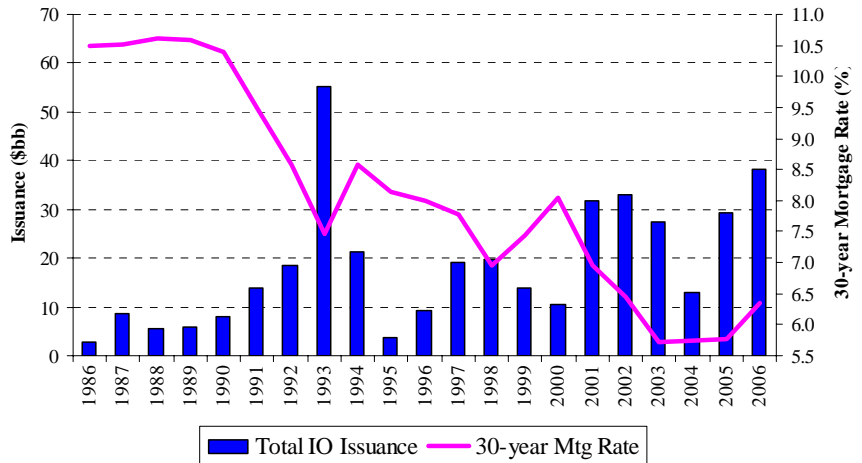
Source: Banc of America Securities

The first SMBS structures date back to the late 80’s and Figure 3 summarizes the issuance of IO classes under the FNS and FHS shelves from 1986 onwards.<sup>5</sup> As the figure suggests, while IO issuance is somewhat correlated to the level of mortgage rates, there appear to be other factors that also play an important role. Essentially, the demand for IO or PO is driven by the investor demand for exposure to prepayment risk, either as an offsetting hedge or because the creation of certain types of structured CMOs has resulted in prepayment risk being inefficiently priced. We will revisit these ideas when

<sup>5</sup> The IO issuance numbers depicted in the figure serve as a good approximation to PO issuance, but the correspondence is not exact. The point is that IO and PO deals may not always be struck off the same principal balance in order to create additional classes in the SMBS with synthetic coupons

we discuss IO/ PO valuation in a later section<sup>6</sup>.

**Figure 3: IO Issuance in SMBS Trusts: 1986-2006\***



\*As of October 2006. We exclude IOs backed by excess servicing.  
 Source: Banc of America Securities

**Liquidity in the IO/PO Market**

Figure 4 shows the volume of outstanding IOs stratified by coupon. While it is correct to assume that 5s, 5.5s, and 6s are the most liquid coupons in the IO/PO market, the numbers shown in the figure are an imperfect proxy for liquidity. The key issue is that unlike the TBA market, IO trusts are not “fungible.” In other words, market participants don’t regard different trusts issued off of the 5.5% coupon (FNS 354 and FNS 352 for example) as substitutes for each other. The nuanced pricing of prepayment risk in the IO/PO market means that in order for this to happen, the collateral underlying the two trusts would have to be virtually identical, and this is rarely the case. Generally speaking, the most recently issued trust for a particular coupon is regarded to be the “on-the-run” benchmark and more seasoned trusts are considered to be less liquid. The other key to understanding liquidity in the IO/PO sector is the IO/PO “Combo.”

<sup>6</sup> The figure doesn’t represent an important source of IO supply that comes from the issuance of **Excess Servicing** deals. Appendix A provides a detailed introduction to these transactions.

**Figure 4: Outstanding Float in the Trust IO/PO Market by Coupon**

| Coupon | Outstanding (\$bb)* |      |       | %Out |
|--------|---------------------|------|-------|------|
|        | FNS                 | FHS  | Total |      |
| 4.50   | 0.3                 | 1.9  | 2.2   | 3%   |
| 5.00   | 12.3                | 10.0 | 22.3  | 28%  |
| 5.50   | 15.4                | 12.6 | 28.1  | 35%  |
| 6.00   | 12.0                | 9.0  | 20.9  | 26%  |
| 6.50   | 3.5                 | 1.2  | 4.7   | 6%   |
| 7.00   | 1.0                 | 0.7  | 1.7   | 2%   |
| >=7.50 | 0.5                 | 0.3  | 0.9   | 1%   |
|        |                     |      | 80.8  | 100% |

\*As of October 2006. Only includes Trusts backed by 30-year mortgages.

Source: Banc of America Securities

### **IO/PO Combos**

An investor who holds both the IO and PO class corresponding to a particular Trust is said to be long the “combo” (short for “combination”) corresponding to that Trust. Owning the combo gives the investor the flexibility of getting long either IO or PO exposure by selling the companion class. Some investors also like to hold the combo by itself in anticipation of its value appreciating significantly if there is a CMO bid for the collateral characteristics underlying either the IO or PO.

Additionally, owning the combo also confers the option of exchanging it for the underlying pass-through pools. This exchange process is termed “collapsing the combo” by market participants. While at first blush it is not obvious why somebody would want to do this, the point is that the exchange option gives the combo holder the ability to access the liquidity of the pass-through market and take advantage of special technical opportunities that exist there. So, for example, let’s say I hold 6% IO and the specified pool market is paying a rich premium for collateral pools with the same characteristics as those backing the IO. In this situation, I would buy the 6% companion PO and using the exchange option to deliver the IO/PO certificates in exchange for 6% pass-through pools, which I would then sell into the specified pool bid.

The exchange option is not free: it varies from deal to deal and agency to agency and can be found in the prospectus statement. The current practice is for most newly issued Trusts to allow free recombinations for a period of 2-3 months after which a 1 tick fee is charged on the current face amount.

Combos are important enough that IO/PO traders will make markets in them. The prevailing convention is to quote combo prices at a spread to the TBA of the appropriate coupon. For example, if broker-dealer X says quotes the offer-side of \$100mm of Trust ABC combo which is backed by 5.5% pools at “0-03”, this means that they will deliver \$100mm of the combo at the 5.5% TBA price plus 3 ticks. The combo is important enough that the market will punish “orphan” IO classes that do not have a companion PO available and vice-versa.<sup>7</sup>

<sup>7</sup> This happens because occasionally large blocks of the IO or PO get locked up in a CMO structure.

### ***Bid-Offer Spreads***

The bid-offer spread on IO transactions typically averages 4 ticks for a size of up to \$50mm to \$75mm on newer trusts, and is wider for larger sizes and older trusts. The bid-offer on IO/PO Swaps (the exchange of IO or PO class for another) and Combos presently averages around 1-2 ticks, although newer trusts have more liquidity. POs are usually considered more illiquid than IOs because of their appeal to long-term investors such as servicers who use these instruments to hedge prepayment risk on their servicing portfolios.

### III. UNDERSTANDING IO/PO PRICE MOVEMENTS AND RISK EXPOSURES

#### Movements in IO/PO Prices: A Simple Example

IOs and POs are exposed to the same laundry list of risks as pass-through securities – interest rate risk, curve shape risk, volatility risk, prepayment model risk, current coupon spread risk etc. However, the risks embedded in pass-through securities are magnified in IOs and POs since the latter set of securities has much greater exposure to prepayments. The goal of this section is to quantify how IO/PO prices move as a function of changes in the above risk factors. In a general sense, we already have a feeling for this issue from an understanding of the pass-through market because of our earlier characterization of IOs as being the “ultimate premium security” and POs as being the “ultimate discount security.”

Let’s begin by asking a very fundamental question: how do we expect IO and PO prices to move as a function of interest rates? To answer this, we need to consider two effects:

- When interest rates change, prepayment speeds change. Thus, the total cash flows received by an IO holder as well as the timing of the cash flows received by the owner of an IO or a PO change. We call this the **cash flow effect**.
- When interest rates change, the discount rates used for estimating the present value of the cash flows received by the owners of an IO or a PO change. We call this the **discount factor effect**.

When interest rates decline and prepayment speeds pick up, the negative impact of the cash flow effect on an IO price usually dominates the positive impact of the discount factor effect from lower rates. As a result, the price of an IO usually falls when interest rates decline. Similarly, when interest rates rise and prepayment speeds slow down, the positive impact of the cash flow effect on an IO price usually dominates the negative impact of the discount factor effect from higher rates. Thus, the price of an IO decreases when interest rates decline and increases when interest rates rise, while the opposite occurs with the prices of POs. Figure 5 presents a simple illustration of this effect. The top half of the table (the “Constant Prepay Assumption” section) shows how IO prices would change as a function of interest rates if we only took the discount factor effect into account. The lower half of the table (the “Dynamic Prepay Assumption” section) illustrates how IO prices change when we take both the cash flow effect and the discount factor effect into consideration. Here, we compute prices by simply taking the present value of the cash flows at the discount rate corresponding to the appropriate interest rate scenario.

**Figure 5: Understanding the Impact of Interest Rates and Prepayments on IO Prices**

Price = 25-29+

Yield = 8.26% (Prepay Assumption = 190 PSA)

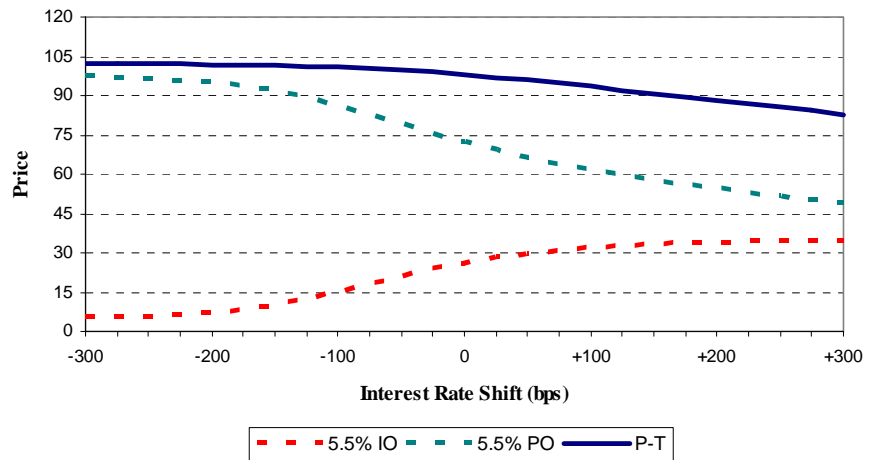
| Scenario                          | -200 bp       | -100 bp       | 0 bp          | +100 bp       | +200 bp       |
|-----------------------------------|---------------|---------------|---------------|---------------|---------------|
| <b>Constant Prepay Assumption</b> |               |               |               |               |               |
| Projected Prepays (% PSA)         | 190 PSA       | 190 PSA       | 190 PSA       | 190 PSA       | 190 PSA       |
| Total Cash Flows (\$mm)           | 1130          | 1130          | 1130          | 1130          | 1130          |
| Discount Rate                     | 6.26%         | 7.26%         | 8.26%         | 9.26%         | 10.26%        |
| <b>Price</b>                      | <b>28-10+</b> | <b>27-02+</b> | <b>25-29+</b> | <b>24-27+</b> | <b>23-28+</b> |
| <b>Dynamic Prepay Assumption</b>  |               |               |               |               |               |
| Projected Prepays                 | 1469 PSA      | 569 PSA       | 190 PSA       | 135 PSA       | 121 PSA       |
| Total Cash Flows (\$mm)           | 165           | 438           | 1130          | 1413          | 1504          |
| Discount Rate                     | 6.26%         | 7.26%         | 8.26%         | 9.26%         | 10.26%        |
| <b>Price</b>                      | <b>5-10</b>   | <b>12-29+</b> | <b>25-29+</b> | <b>28-26</b>  | <b>30-00</b>  |

Source: Banc of America Securities

**IO/PO Duration and Convexity Profiles**

Figure 5 provides a somewhat theoretical illustration of how IO prices vary as a function of prepayments and interest rates. Figure 6 provides a more realistic view of how IO (and PO) prices change in the market as a function of interest rates, assuming OASs remain constant.

**Figure 6: Constant OAS Pricing for IO, PO, and Collateral**



Source: Banc of America Securities

Another way to get a feeling for movements in IO/PO prices as a function of interest rates is to compute OAS-based duration and convexity measures for these securities and also get a feeling for how these measures vary with rate levels. As the bottom two graphs in Figure 7 demonstrate, the effective duration and convexity profiles of IO and PO securities exhibit significant disparity relative to each other, and also with respect to the underlying collateral. For example, the graphs show that the 5.5% IO has a large negative duration and negative convexity while the 5.5% PO has high positive duration and

positive convexity (in the 0 bps shift case). Notice also that the interest rate sensitivity of Trust IOs and POs changes significantly with the level of interest rates. We now explore how the duration and convexity of IO/PO cash flows varies with rates.

#### ***Duration and Convexity Profile of a PO***

As interest rates fall from the baseline case (0 bps shift), prepayment speeds on the collateral begin to accelerate. For a PO, both the high speeds (“the cash flow effect”) and lower discount rates (“the discount rate effect”) work in conjunction to boost its price when interest rates decline. As interest rates continue to decline, both the duration and the convexity of the PO begin to fall. This is because prepayment speeds become less sensitive to interest rate changes at low rate levels as indicated by the levelling off of the prepayment S-curve (the first graph in Figure 7). In this particular situation, the duration of the PO remains positive throughout the interest rate range whereas the convexity changes its sign at low interest rate levels. The negative convexity of POs at very low interest rates just signifies that the duration of the PO begins to decline at these low interest rate levels.

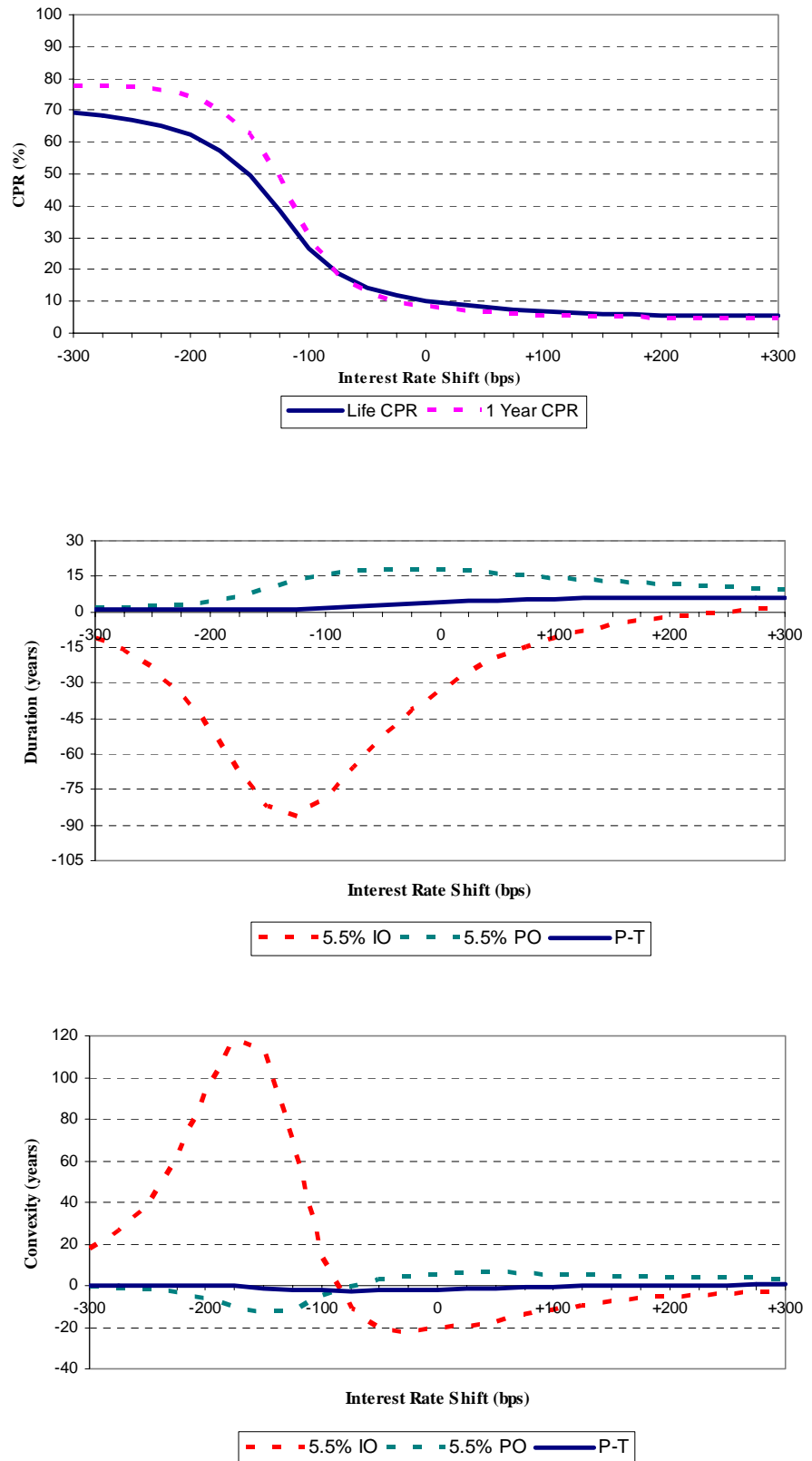
When interest rates increase, slower prepayment speeds along with higher discount rates knock down the price of a PO. However, as interest rates continue to rise, the price of the PO falls at a lower rate due to the levelling off of prepayment speeds.

#### ***Duration and Convexity Profile of an IO***

In the case of IOs, as interest rates fall, higher speeds overwhelm the impact of lower discount rates initially and lead to a sharp decline in prices. The duration of the 5.5% IO becomes more negative owing to the sharp increase in prepayment speeds (“high negative convexity”). However, a continued rally of interest rates leads to levelling off in IO price declines as a consequence of a combined effect of lower discount rates and prepayment speeds starting to max out at the higher end of the prepayment S-curve (see the first graph in Figure 7). At low rate levels, the IO becomes positively convex signifying that the IO price is so low at these interest rate levels that it has much more room to rise than to fall.

When rates rise, the price of an IO increases initially as the beneficial impact of slower prepayment speeds outweighs the negative impact of higher discount rates. As rates continue to rise and speeds level off at the lower end of the prepayment S-curve, the effect of higher discount rates becomes dominant. As a result, the duration starts to increase and beyond a certain point, further increases in rates lead to a decline in prices and the duration becomes positive.

Figure 7: Effective Duration and Convexity of IO/PO Securities and Collateral



Source: Banc of America Securities

**IO/PO Risk Exposures**

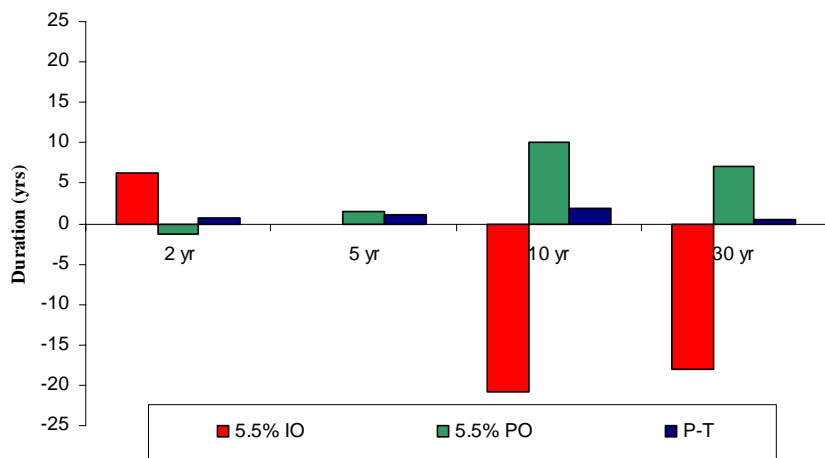
Our discussion of IO/PO duration and convexity gives us a clear picture of the interest rate risk (duration risk) posed by these securities. We now discuss some of the other risks associated with IO/PO investments.

**Curve Shape Risk**

Effective duration is a good measure of interest rate risk as long as the whole yield curve moves in parallel. Trust IO/PO prices can also change because of changes in the shape of the yield curve and the associated risk is referred to as **curve shape risk**. To evaluate curve shape risk, market participants typically calculate partial durations with respect to different parts of the yield curve.

Figure 8 illustrates what these partial durations look like for 5.5% IO, PO, and Collateral. Although IOs lose value in general due to faster prepayments when interest rates fall, they actually have a relatively strong positive duration with respect to the 2-year rate. In other words, IO prices increase when the 2-year rate rallies, even though the negative effective duration of the IO means that its price will decline when the yield curve rallies in parallel. This happens because any short-term loss in value due to marginally faster prepayments resulting from declines in short-term rates is overwhelmed by higher mortgage rates on the forward paths which lowers long-term speeds. The opposite occurs with POs. Owing to their extreme discount nature, POs exhibit negative partial durations with respect to the 2-year rate even though they usually have a strong positive effective duration.

**Figure 8: Curve Risk Exposures of 5.5% IO, PO, and Collateral**



\*The exposure of the IO to the 5-year is almost zero.  
Source: Banc of America Securities

**Prepayment Model Risk**

The potential for differences between realized prepayment rates and prepayment rates forecasted by the model leads to the notion of **prepayment risk** or **prepayment model risk**. This risk is distinct from the risk of interest rate-related changes in prepayment speeds. Prepayment risk arises either due to structural changes in the mortgage market or due to differences between market prepayment expectations and model projections. The price sensitivity of MBS to changes in prepayment levels from a defined base level, while keeping interest rates constant, is measured through **prepayment duration**. An extension of this concept is to calculate **partial prepayment durations**, which measure the price sensitivity with respect to deviations from the base level for a specific component of prepayments. The most important partial prepayment durations are the **Turnover Duration** and the **Refinance Duration**, which measure, respectively, the impact of higher or lower than projected home sales and refinancing rates on the price of an MBS.

Prepayment durations are positive for premium coupon mortgage pass-throughs and negative for discount coupon pass-throughs since faster than expected speeds hurt premium coupons and benefit discount coupons (see Figure 9). Consequently, an IO always has positive prepayment duration regardless of whether the underlying collateral is trading at a discount or a premium. On the other hand, a PO always has negative prepayment duration.

**Figure 9: Prepayment Model Exposure of 5.5% IO, PO, and Collateral**

|         | <b>Prepay Duration / DV01</b> | <b>Price Change (ticks) / 1% Prepayment Model Multiplier Increase</b> |
|---------|-------------------------------|---|
| 5.5% IO | 0.5 / 0.0013                  | $-0.0013 \times 32 \times 100 = -4.16$                                |
| 5.5% PO | -0.189 / -0.00136             | $0.00136 \times 32 \times 100 = 4.352$                                |
| P-T     | -0.009 / -0.00009             | $0.00009 \times 32 \times 100 = 0.288$                                |

Source: Banc of America Securities

**Mortgage Spread Risk (Current Coupon Risk)**

This risk measure captures the effect of widening and tightening of mortgage spreads on the prices of IOs and POs. Wider mortgage spreads equate to higher mortgage rates at the same Treasury/Swap rate levels and thus lead to slower prepayment speeds. Similarly, tighter mortgage spreads lead to faster prepayment speeds. Thus, current coupon spread widening is usually beneficial for premium coupon mortgage pass-throughs and has a detrimental impact on discount coupon pass-throughs. The price risk arising from change in mortgage spreads is referred to as **mortgage spread risk** or **current coupon spread risk**.

Premium coupon pass-throughs usually have negative current coupon spread duration whereas discount coupon pass-throughs have positive current coupon spread duration. Consequently, IOs and POs always have very strong negative and positive current

coupon spread durations respectively, regardless of the coupon rate on the underlying collateral. In other words, an IO always benefits from current coupon spread widening while a PO always benefits from current coupon spread tightening.

Figure 10 shows the current coupon spread sensitivity of a 5.5% IO and PO. For a 10 bps increase (widening) in mortgage spread, the 5.5% IO gains 31 ticks, while the 5.5% PO loses 29.7 ticks. The magnitude of current coupon spread exposure of the underlying collateral is usually a lot less than that of the IO or the PO. In the case below, the underlying collateral gains only 0.6 ticks for a 10 bps widening in current coupon spreads.

**Figure 10: Current Coupon Spread Exposure of 5.5% IO, PO, and Collateral**

|         | CCS Duration / DV01 | Price Change (ticks) / 1bps CCS Increase |
|---------|---------------------|--|
| 5.5% IO | -36.948 / -0.097    | $0.097 \times 32 = 3.104$                |
| 5.5% PO | 12.93 / 0.093       | $-0.093 \times 32 = -2.976$              |
| P-T     | -0.194 / -0.002     | $0.004 \times 32 = 0.064$                |

Source: Banc of America Securities

### Volatility Risk

MBS pass-throughs have a positive duration with respect to interest rate volatility since a rise in volatility increases the value of homeowner's prepayment option. For IOs, which have a leveraged short position in the prepayment option relative to the underlying pass-through, the negative effect of the increase in volatility on prices is magnified. On the other hand, POs are long the homeowner's prepayment option and hence have negative volatility duration. The price sensitivity of 5.5% IO and PO with respect to changes in volatility is shown in Figure 10. For a 10 bps increase in interest rate volatility, the 5.5% IO loses about 22 ticks versus the PO, which records a modest gain of about 9 ticks.

An important distinction needs to be made between the overall impact of volatility changes on Trust IO prices and the volatility risk measures shown in Figure 11. Assuming that OASs remain constant, when volatility increases we see current coupon mortgage spreads widen (the "mortgage spread risk" discussed in the previous subsection) which helps IOs. Thus, the total impact of volatility changes on IO prices consists of two different components: An IO price change due to mortgage spread changes caused by volatility movements and an IO price change due to volatility changes alone (at constant mortgage spreads). The combined effects of these two changes can sometimes have IO prices rising when volatility increases and declining when volatility decreases.

**Figure 11: Volatility Exposure of 5.5% IO, PO, and Collateral**

|         | <b>Vol Duration / DV01</b> | <b>Price Change (ticks) / 1bps Vol Increase</b> |
|---------|----------------------------|---|
| 5.5% IO | 26.3 / 0.068               | -0.068 x 32 = -2.176                            |
| 5.5% PO | -3.8 / -0.0271             | 0.0271 x 32 = 0.8672                            |
| P-T     | 4.2 / 0.0414               | -0.0414 x 32 = -1.3248                          |

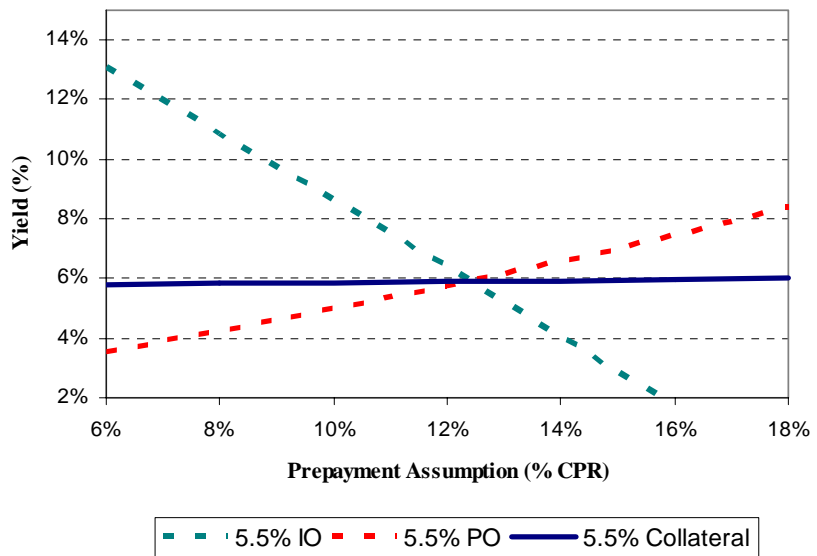
Source: Banc of America Securities

### IV. METRICS FOR IO/PO VALUATION

#### Yield

The shortcomings of yield as a measure of total return and value for pass-throughs are accentuated for IOs and POs because of the extreme sensitivity of these instruments to prepayment speeds. Take a look at Figure 12: notice that the yield on the IO decreases by 230 bps when long-term prepayment speeds increase by 2% CPR from 12% CPR to 14% CPR, and increases by 228 bps if prepayment speeds decrease by 2% CPR from 12% CPR to 10% CPR. Contrast this to the situation for pass-throughs where the corresponding numbers are 4 bps and 3 bps respectively.

**Figure 12: Yields on 5.5% IO, PO, and Collateral as a function of prepayment speeds**



Source: Banc of America Securities

#### Option-adjusted Spread (OAS)

As discussed in our primer on MBS pricing<sup>8</sup>, the accurate pricing of MBS takes into account the variation in cash flows in different interest rate scenarios resulting from the exercise of the prepayment options by the underlying homeowners. Thus, calculating the OAS on an IO or PO gives us a much better perspective on the return for a potential investor than a yield. Still, the OAS measure is far from perfect because of the presence of prepayment model risk. As our earlier calculations in Figures 9 and 12 demonstrate, even a small difference between actual and realized prepayment speeds can lead to a very different return profile than the one initially assumed. The presence of this model risk results in the OASs of IO, PO and pass-throughs created from the same Trust being quite different. In general, IOs have the highest OAS to compensate the investor for the higher prepayment risk embedded in these securities. This issue is further discussed in Appendix B.

<sup>8</sup> See “Pricing Mortgage-backed Securities.”

### A Case Study in IO Valuations

To get some feeling for how OASs on Trusts can vary as a function of market conditions, Figure 13 plots the OAS history of Trust 328 IO, a 6% IO with a GWAC of 6.46%, over 2003-2005. Notice the dramatic movements in IO OASs over this period from a low of -250 bps to a high of 1150 bps. We review some of the driving forces behind these swings.

Trust IOs were trading at very low OASs at the beginning of 2003 because of the steep yield curve and the specialness of the dollar roll on current coupon pass-throughs. Attracted by the attractive carry of Trust IOs hedged with current coupon collateral, institutional investors bought Trust IOs in size. Trust IO valuations then nosedived over the spring and summer of 2003 because of a combination of factors:

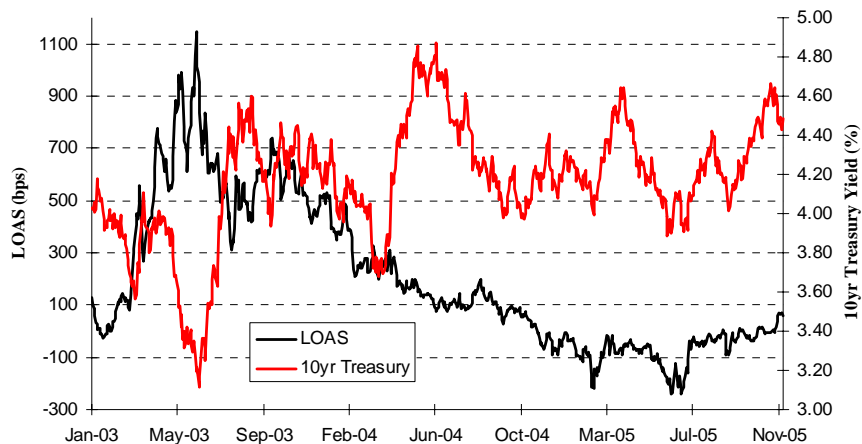
- First, there was substantial supply of structured IOs (from CMO deals) in the market. Due to historically low rates, most of the mortgage universe consisted of premium mortgages at that time. Broker-dealers structuring CMO deals had to sell the premium in the form of structured IOs which flooded the market with Trust IO-like cash flows.
- Second, prepayment speeds on premium collateral were a lot faster than what the market expected during the 2003 Refi wave. This was largely due to the generational lows in interest rates and the resultant very strong media effect. These faster than expected prepayment speeds hurt IO valuations.
- Third, prepayment speeds on 30-year 6% pools reached as high as 60%-70% CPR. At these prepayment speeds, carry on 6% IOs was very negative, which drove carry players away from the market.
- Finally, realized volatility was very high and implied volatility spiked up as well causing a surge in both actual and expected losses from negative convexity. Although 6% IOs had positive convexity in the early summer of 2003 when the 10-year Treasury hit 3.10%, their convexity profile turned negative as rates backed up from those very low levels. The high negative convexity losses during the summer of 2003 further reduced demand for IOs.

After rebounding somewhat over the latter half of 2003, Trust IO OASs stabilized at the beginning of 2004 when the 10-year Treasury yield dropped to 3.65%, rekindling prepayment fears. However, as 2004 progressed, IO spreads tightened substantially and Trust IOs closed the year at very tight OASs. Some of the important factors that contributed to this IO spread tightening include:

- The implied volatility of swaptions declining by 15-20 bps, which increased demand for Trust IOs.
- Prepayment speeds on 30-year 6s and 6.5s declining from their lofty levels of 60%-80% CPR to 30%-50% CPR. The slowdown in prepayment speeds improved carry on IOs and made them attractive to carry players.
- The 10-year Treasury stabilized in a range of 3.95%-4.40% during the second half of 2004 and realized volatility in the market was very low. Naturally, all negative convexity products tend to perform well in this type of environment.

IO OASs were fairly range bound over 2005 relative to 2003 and 2004 with some peaks and troughs in performance. Faster than expected speeds, a steady supply of Excess IO from servicers and a flat yield curve counteracted the effect of low volatility and a muted prepayment environment.

**Figure 13: OASs on Trust 328 IO: 2003 to 2005**



Source: Banc of America Securities

## V. INVESTING IN IO/PO

The unusual duration and convexity characteristics of IOs and POs appeal to a wide range of customers with different investment motives. Investors can use these instruments to hedge prepayment or interest rate risk; express views on interest rates, spreads and volatilities; take advantage of any arbitrage opportunities vis-à-vis underlying collateral; create desired investment or duration profiles; or simply benefit from attractive carry. Figure 14 summarises some typical IO/PO investment rationales for different classes of institutional investors.

**Figure 14: Investment Rationale for Trust IOs and POs**

| INVESTOR TYPE                                 | INVESTMENT RATIONALE   | IO/PO   |
|---|--|---------|
| <b>Hedge Funds</b>                            | Express a view on interest rates or prepayment rates   | IO / PO |
|   | Attractive carry under different prepayment scenarios  | IO / PO |
|   | Excess return in market-neutral trading strategies   | IO / PO |
|   | Create investments with desired duration/convexity profiles  | IO / PO |
| <b>Money Managers and Insurance Companies</b> | Cheapest negative duration alternative to hedge a sell off in interest rates   | IO      |
|   | Only negative duration alternative for accounts with prohibitions on short selling and using off-balance sheet derivatives | IO      |
|   | Hedge prepayment risk  | PO      |
| <b>Mortgage Servicers</b>                     | Hedge prepayment and interest rate risk of servicing portfolios  | PO      |

Source: Banc of America Securities

### Typical Trades

#### **Zero-Duration Combinations of Trust IOs and Current Coupon TBAs**

Investors who expect interest rates to be range bound can create duration-neutral combinations of Trust IOs and current coupon collateral as an alternative to holding cash (recall that Trust IOs have negative duration). These combinations can offer attractive carry in return for being short convexity and hence, by implication, (implied) volatility.

#### **Synthetic Premium and Synthetic Discount Trades**

A popular trade in the Trust market is to combine a pass-through security with an IO or a PO to create a **synthetic premium** or a **synthetic discount** security. The synthetic security will have a coupon rate that is different from the coupon of the original pass-through used for creating the synthetic security. This trade is typically used when investors believe that IOs and POs offer a cheaper alternative for going up-in-coupon or down-in-coupon across the pass-through coupon stack. For example, suppose an investor thinks that 30-year 5.5% passthroughs are very rich relative to 30-year 5s and it is

cheaper to go up-in-coupon using 5% Trust IOs. They can buy \$100 TBA 5s and \$10 Trust 5% to create a \$100 synthetic 5.5% security.

Synthetic coupons can also be created by combining Trust IOs and POs in different proportions. Depending upon the proportion of IOs and POs in the combination, the resulting synthetic coupon may have a different risk profile than that of the underlying collateral. For example:

- More POs than IOs results in a lower coupon than the underlying collateral:
  - \$10mm 6% IO + \$15mm 6% PO = \$15mm 4% Synthetic Coupon
- More IOs than POs results in a higher coupon than the underlying collateral:
  - \$15mm 6% IO + \$10mm 6% PO = \$10mm 9% Synthetic Coupon

#### **Combo Trade versus TBAs**

In this trade, an investor combines IOs and POs from the same Trust or from two different Trusts to create a synthetic pass-through (or a “Combo”). The synthetic passthrough collateral characteristics – GWAC, WALA, loan size etc. – may be quite different from the collateral corresponding to the TBA of the same coupon. Investors put on this trade when they believe that the market is not correctly pricing in the specified pool characteristics (seasoning, burnout etc) of collateral.

For example, suppose that an investor thinks that the market is underpricing the value of the burnout in 1997 vintage FNMA 6.5s. In this situation, the investor could express their opinion by buying IOs and POs of a 6.5% Trust backed by pools originated in 1997 and short TBA 6.5s.

#### **IO/PO Swaps**

Here, an investor buys an IO (PO) of a Trust backed by a specific coupon and shorts an IO (PO) of a different Trust. The Trusts may or may not have the same coupon but will be backed by different collateral. This trade is used when an investor perceives that the market is not correctly pricing in the relative prepayment risks in the collateral backing the two different Trusts.

## APPENDIX A. EXCESS SERVICING IO-BACKED MBS

Since 1999, there have been a number of MBSs issued under the FNS and FHS labels that securitize the **excess servicing** from servicer portfolios. Figure 14 contains a list of all the issued deals up to September 2006. How is this excess servicing generated? Recall that servicers collect payments from the underlying homeowners in an MBS pool and forward these payments to the relevant Agency. In return for performing this service, they are allowed to collect an IO strip. This IO strip is part of the spread between the gross coupon (GWAC) on a pool of loans and the pass-through rate. In general, this spread (loosely referred to as the “servicing spread”) consists of three components: (1) The guarantee fee; (2) The net amount of coupon purchased/sold by the lender using the GSE buy-up/buy-down program; and (3) The lender’s servicing takeout (25bps of base servicing plus excess servicing).

To make our discussion above completely rigorous, we define excess servicing as follows:

- Interest rate on the mortgage loan (+)
- Pass-through rate on the FNMA or FHLMC MBS backed by that mortgage loan (-)
- Guarantee fee (-)
- Minimum servicing fee (-)
- Premium amounts required to be paid for the lender for lender-purchased mortgage insurance

Excess servicing is securitized under the FNS and FHS shelves because it consists of IO. However, an excess servicing deal is unlike a regular Trust in that it doesn’t contain a companion PO class for the IO. For an excess servicing deal securitized under the FHLMC (FNMA) shelf, only loans that are already in FHLMC (FNMA) pools may be included. There are some other restrictions in terms of loans that can be placed in excess servicing deals with the common ones being that all loans with zero excess servicing and non-standard remittance cycles are excluded. Also, non-current loans (delinquent loans, loans in foreclosure) cannot be included in these transactions.

Figure 15. Excess Servicing IO Deals: 1999 – October 2006

| Trust   | Pricing Date | Collateral    | Servicer          | Issue Balance (\$mm) |
|---------|--------------|---------------|-------------------|----------------------|
| FNS 305 | 11/3/1999    | 30-yr         | Countrywide       | 797.0                |
| FNS 323 | 4/24/2002    | 30-yr         | Countrywide       | 1397.4               |
| FNS 325 | 6/18/2002    | 30-yr         | Washington Mutual | 3209.5               |
| FNS 330 | 11/18/2002   | 15-yr & 30-yr | Washington Mutual | 1219.1               |
| FNS 331 | 12/19/2002   | 15-yr & 30-yr | Countrywide       | 1487.7               |
| FNS 334 | 2/19/2003    | 15-yr & 30-yr | Countrywide       | 1627.1               |
| FNS 335 | 3/19/2003    | 15-yr & 30-yr | Washington Mutual | 1316.1               |
| FNS 336 | 5/19/2003    | 15-yr & 30-yr | Washington Mutual | 3007.7               |
| FNS 339 | 6/19/2003    | 15-yr & 30-yr | Countrywide       | 2899.8               |
| FNS 343 | 9/22/2003    | 15-yr & 30-yr | Countrywide       | 1378.3               |
| FNS 345 | 11/19/2003   | 15-yr & 30-yr | Washington Mutual | 1169.8               |
| FNS 348 | 12/17/2003   | 15-yr & 30-yr | Countrywide       | 795.8                |
| FNS 351 | 3/19/2004    | 15-yr & 30-yr | Countrywide       | 527.5                |
| FNS 355 | 11/23/2004   | 15-yr & 30-yr | Countrywide       | 207.0                |
| FNS 356 | 12/16/2004   | 15-yr & 30-yr | Countrywide       | 1066.8               |
| FNS 359 | 6/17/2005    | 15-yr & 30-yr | Countrywide       | 777.9                |
| FNS 362 | 8/22/2005    | 30-yr         | GMAC              | 1252.5               |
| FHS 233 | 9/13/2005    | 30Yr          | Countrywide       | 713.0                |
| FNS 364 | 11/21/2005   | 30-yr         | CitiMortgage      | 1520.9               |
| FNS 365 | 12/20/2005   | 30-yr         | Countrywide       | 1509.7               |
| FNS 366 | 12/20/2005   | 15-yr & 30-yr | Bank of America   | 985.7                |
| FNS 368 | 3/20/2006    | 15-yr         | SunTrust          | 464.0                |
| FNS 369 | 3/20/2006    | 30-yr         | Countrywide       | 668.8                |
| FHS 238 | 5/12/2006    | 30-yr         | Countrywide       | 497.5                |
| FNS 374 | 8/24/2006    | 30-yr         | Countrywide       | 649.7                |
| FHS 241 | 9/14/2006    | 30-yr         | Wells Fargo       | 95.8                 |
| FNS 376 | 9/22/2006    | 30-yr         | Wells Fargo       | 112.3                |
| FHS 244 | 10/19/2006   | 15-yr & 30-yr | Bank of America   | 400.0                |

Source: Banc of America Securities

**Excess Servicing IO Structures**

Each excess IO deal typically has a cluster of IO classes for each coupon, with the coupons usually ranging from 5% to 6.5%.<sup>9</sup> The typical cluster of tranches corresponding to one coupon in an excess servicing IO deal is summarized in Figure 16. As the figure shows, there are two types of tranches:

<sup>9</sup> When the collateral consists of 30-year mortgage loans. The range of IO coupons for 15-year mortgage loans will be shifted downward by 50bps.

- **Fixed IO class** (Class 1, 2): Each such class has a fixed interest rate for life. Each mortgage loan represented in this group contributes the same amount of excess servicing.
- **WAC IO class** (Class 3): Each such class has an interest rate that represents an effective weighted average interest rate, and that may change from period to period. Each mortgage loan represented in this group can contribute a different amount of excess servicing.

Multiplying the class coupon by the conversion factor (column 3 in the figure) for a fixed IO class gives us the amount of excess servicing contributed by each loan. For example, each loan contributes 12 bps of excess servicing to Class 1.

**Figure 16: Typical Excess Servicing IO Structure**

| Class | Principal Balance | Factor | Type | Rate | Type   |
|-------|-------------------|--------|------|------|--------|
| 1     | 106,493,290       | 0.0218 | NTL  | 5.5  | FIX/IO |
| 2     | 68,417,507        | 0.0445 | NTL  | 5.5  | FIX/IO |
| 3     | 19,405,777        |        | NTL  | 5.5  | WAC/IO |

Source: Banc of America Securities

### Excess Servicing IO Collateral Characteristics

Some care must be taken in terms of calculating the “average” characteristics of the collateral backing excess IO deals. Consider the following example. Suppose we have 3 loans, all with the same principal balance, and that the IO contribution of these loans to the WAC IO is 5 bps, 10 bps, and 15 bps respectively. Clearly, the loan with 15 bps of excess IO is contributing three times the cash flow to the WAC IO versus the loan with 5 bps. Therefore, it is intuitively more appropriate to assign three times the weight of the collateral characteristics of the 15 bps loans versus the 5 bps loans when calculating “average” characteristics. Collateral averages such as WAC, WAM, WALA and Loan Size calculated using this weighting scheme are known as **contributed** averages since the weighting is done not by loan balance but by the total amount of IO cash flow contributed by each loan.

For fixed IO tranches, computing weighted-average collateral characteristics by current loan balance or by contributed IO balance produce the same result since each loan in a fixed IO tranche contributes the same amount of excess servicing.

### Pricing a Typical Excess Servicing IO Structure

Given a class in excess IO structure, the pricing process starts by finding the Trust IO (with the same coupon) with collateral characteristics most closely resembling the collateral backing the excess servicing IO tranche. In practice, the collateral backing the excess servicing IO tranche will differ from that of the Trust IO in a number of different ways including more dispersion, more/less seasoning, higher/lower GWACs etc. A good prepayment model should be able to price these factors and thus the second step in the pricing process consists of assuming the excess servicing IO trades at the same OAS as its benchmark. The excess IO tranche price we obtain using this OAS differs from the Trust IO price only because of differences in the collateral underlying these two tranches (there may be settlement date issues to consider as well).

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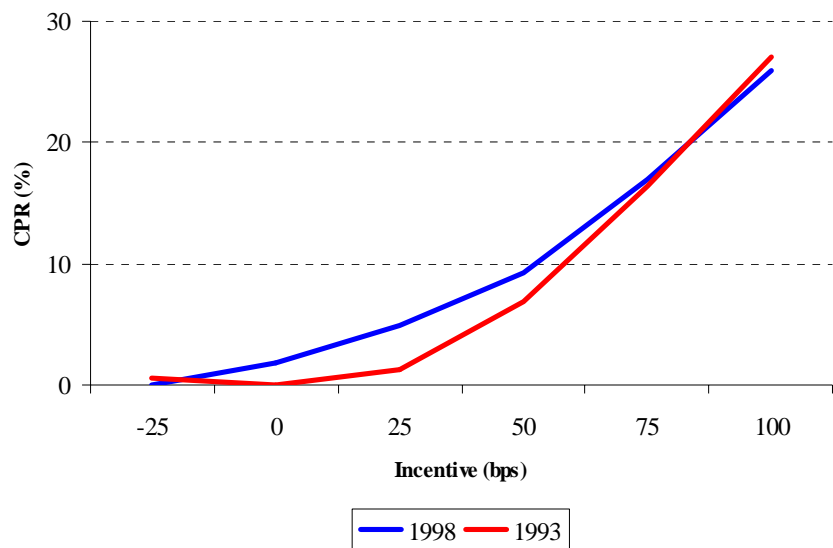
The final step lies in applying a **discount factor** to the price obtained in step 2. The discount factor has varied over history and has been as low as 92% and as high as 98%. The discount is essentially a concession for the liquidity risk and single servicer risk assumed by the excess IO investor. The liquidity risk arises from the fact that the excess IO tranche has no companion PO tranche unlike the Trust IO. The servicer risk arises from the fact that the excess IO investor has exposure to the servicing practices of one particular originator as opposed to the mix of originators that is typically backing a Trust. The discount factor for the WAC IO tranche is typically 2-3% lower than the concession for the fixed IO tranche because of the greater loan dispersion in the WAC IO tranches.

**APPENDIX B. THE BREAK-EVEN PREPAYMENT MODEL**

**Defining Prepayment Risk**

The traditional view of prepayment risk was focused on analyzing how prepayment rates vary with interest rates. This view of prepayment risk is essentially analogous to the negative convexity risk in MBS and is captured by the OAS calculation. As we discussed in the section on prepayment model risk (also commonly referred to as **structural prepayment risk**), MBS investors also have to consider the risk that their prepayment model is “wrong” – In other words, the future turns out to be different from the past. This can happen in a host of different ways including changes in the underwriting process, changes in the ways servicers operate etc. For example, the increasing adoption of automated underwriting by originators starting in 1995-1996 decreased the time and cost associated with the mortgage application process and reduced the cost of refinancing. Figure 17 illustrates how this cost reduction led to a shift in the refinancing S-curve and exemplifies one aspect of structural prepayment risk: The refinancing efficiency of homeowners typically increases over time but it is not easy to predict the amount and timing of these improvements.

**Figure 17: The Refinance S-Curve in 1993 and 1998**



Source: Banc of America Securities

**The Market Pricing of Prepayment Risk**

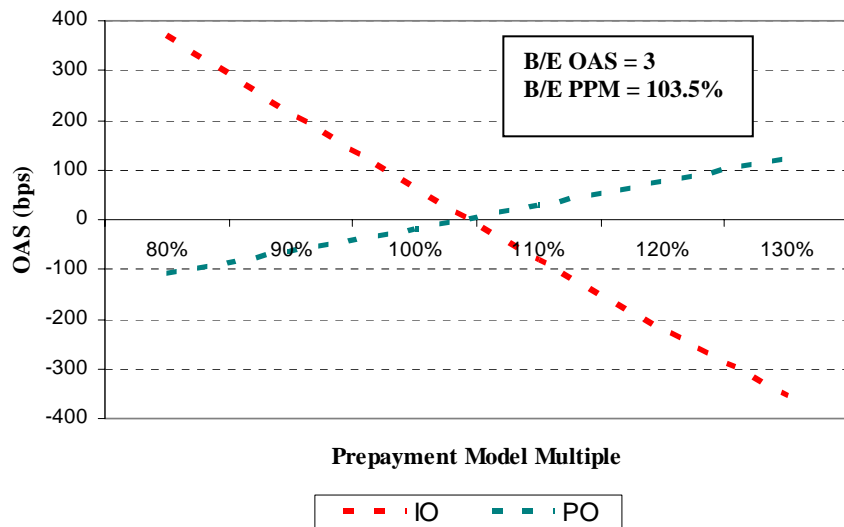
Structural prepayment risk is not captured by traditional convexity measures and it cannot be hedged using Treasuries, Swaps and Options. To some extent, it is hedgeable through mortgage derivatives. Since this risk is non-diversifiable, investors expect additional return (OAS) for this risk. Thus, differences in OAS among different MBSs may not provide an indication of relative value because these MBSs may have different exposures to prepayment risk. This is one reason why IO, PO and pass-through OASs are often different.

**The Breakeven Prepayment Model<sup>10</sup>**

If the prepayment model were perfect and investors were not risk-averse with respect to prepayment model risk, then all MBS would trade at the same OAS.<sup>11</sup> This idea constitutes the kernel of the breakeven prepayment model approach. The breakeven prepay model percentage is the percentage of the prepay model that results in the IO and PO of the same Trust having the same OAS (see Figure 18). Without going into the technical details, the point is that by following this process we can calibrate the prepayment model to the market expectation of prepayments and the market price of prepayment risk. IOs and POs are essential to this calibration process because their sensitivity to prepayment speeds implies that we can gauge market expectations for prepayment speeds from their prices.

How do we use the breakeven prepayment model in practice? For a prepayment risk-neutral investor, a breakeven prepayment model percentage greater than 100% implies that the market is assuming prepayment speeds are going to be faster in the future than the model is currently assuming. This can mean one of two things. First, if the market is “wrong”, the IO is cheap relative to the PO. On the other hand, if the market is “right”, the IO may not be cheap and the prepayment model is too slow. Thus, in practice, market participants often use breakeven prepayment model percentages to gauge what the market’s expectations for prepayment speeds are relative to what the prepayment model is predicting.

**Figure 18: Determining the Breakeven OAS and the Breakeven Prepayment Model Multiple**



Source: Banc of America Securities

<sup>10</sup> The breakeven prepayment model is also often referred to as the **market-implied prepayment model**.

<sup>11</sup> Assuming no financing advantages existed for pass-throughs.

### APPENDIX C. THE TRUST SETTLEMENT PROCESS

Trusts have a somewhat peculiar settlement convention. They settle either on trade date plus two business days ( $T + 2$ ), or on the TBA settlement date corresponding to underlying collateral, whichever comes later in the settlement month. Let's work through an example to clarify how this works in practice. The 30-year conventional TBA settlement dates for October 2004 and November 2004 are October 14<sup>th</sup> and November 15<sup>th</sup> respectively. The following settlement conventions apply to a Trust backed by 30-year conventional collateral:

- All trades occurring between September 29<sup>th</sup> and October 12<sup>th</sup>, both days inclusive, will settle on October 14<sup>th</sup> (the TBA settlement date). This is because the corresponding  $T + 2$  business days for trades during this period range from October 1<sup>st</sup> to October 14<sup>th</sup>, which is earlier than or the same as the TBA settlement date for October.
- All trades from October 13<sup>th</sup> to October 27<sup>th</sup>, both dates inclusive, will settle on the corresponding  $T + 2$  business days, which range from October 15<sup>th</sup> to October 29<sup>th</sup>. For example, on October 13<sup>th</sup>, the Trust settlement date will be October 15<sup>th</sup>; on October 14<sup>th</sup>, the Trust settlement date will be October 18<sup>th</sup>, and so on.  $T + 2$  business days for all of the above trade dates comes after the TBA settlement date of October 14<sup>th</sup>.
- Finally, for all trades from October 28<sup>th</sup> to November 11<sup>th</sup>, the Trust settlement date will be November 15<sup>th</sup>.<sup>12</sup>

One interesting byproduct of the Trust IO/PO settlement convention is that the change in settlement convention from Skip to Regular at month-end requires an estimate of the expected prepayment speed of the Trust for that particular month (in market parlance, the speed at which the Trust is "rolled" at). Since IO/PO prices are so sensitive to prepayments, a lot of attention is paid to these estimates.

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<sup>12</sup> October 30<sup>th</sup>, 2004 was a holiday

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