**Mortgage Research**
J.P. Morgan Securities Inc.
New York, April 2003

JPMorgan

# The JPMorgan Prepayment Model: "It's All About Economics"

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- **Introduction: A Brief History of Prepayment Modeling**

  The history of prepayment modeling is fraught with ad hoc variables and a lack of focus on the fundamentals. We discuss why prepayment models have failed repeatedly, concentrating on the tendency to fit rather than explain prepayments.

- **Key Model Features**

  A summary of the most salient features of the JPMorgan model, focusing on the incentive function.

- **Curve at Origination (CATO)**

  Use of the Curve at Origination is a new development in prepayment modeling. The *change* in yield curve since origination represents the borrowers additional incentive to refinance down the curve.

- **Spread at Origination (SATO)**

  The Spread at Origination is a proxy for non-standard loan characteristics that typically lead to rate premiums at origination. We examine the impact of SATO on prepayment behavior and its model implementation.

- **Impact of Loan Size**

  Loan size continues to be an important determinant of prepayment behavior. Empirical analysis suggests the impact of loan balance on prepayment speeds is as pronounced today as it was two years ago.

- **Home Price Appreciation**

  There is now sufficient prepayment data over varying housing markets to be able to incorporate home price appreciation in prepayment models.

- **Burnout**

  Despite a more accurate incentive function, some burnout was required, and we discuss its implementation in the JPMorgan prepayment model.

- **Turnover Model**

  The economics driving turnover. We provide a synopsis of the function.

- **Refinancing Model**

  Putting it all together. We discuss the S-curve and the mortgage rate.

- **GNMA Prepayments**

  There are various unique characteristics of FHA/VA loans that require a separate discussion of GNMA prepayments. We discuss why CATO, SATO and loan size are less relevant for the GNMA model.

- **Historical Performance**

  We display historical fits by WALA and origination year.

**Contents**



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# 1. Introduction

## A little Philosophy and a little History…

**"Rational expectations" …economic incentive and self-selection are the fundamental building blocks**

We believe that in recent years Street prepayment models have strayed from economics and have increasingly relied on the fitting of data with complicated *ad hoc* parameterizations, e.g., the "media" or "new low" effect, refinancing aging ramps, etc… Rather than focusing on the economics behind the observations, many prepayment models, in our view, have "fixed" model mis-specifications by over-parameterizing. This is the Ptolemaic world-view of prepayments: if new data does not fit the model, simply add another variable (or "epicycle"). With five significant refinancing episodes in the last 10 years, there is now sufficient data to simplify prepayment modeling by introducing more economics and fewer parameters.

**…the model in a nutshell.**

The philosophy underlying the JPMorgan prepayment model is that the prepayment behavior of large pools can be explained exclusively through economic incentive and the self-selection implied by market conditions at origination. Therefore, refinancing is determined only by economic incentive and industry capacity (which may be both mortgage banker as well as back-end capacity), not the "media". The main new variables being used are the yield curve at origination (CATO) and cumulative home price appreciation. We also use traditional self-selection variables such as spread-at-origination (SATO), which implies information on points paid, and/or the presence of non-standard underwriting, such as low documentation or high LTV. The choice of explanatory variables in a prepayment model will significantly impact the computed option cost and duration of a mortgage. Two prepayment models may have similar historical fits, yet produce dramatically different OAS and OAD, if the data is explained by different variables. With the release of more pool specific data in June, we hope to further update the SATO component to incorporate the actual drivers of off-market mortgage rates.

**A little history of prepayment modeling…**

Prepayment modeling in the early-1990s was hampered by limited computational power and insufficient data. The 1993 refinancing wave was notable for a 30-year low in mortgage rates, a steep yield curve, and a relatively weak housing market. In hindsight, it was virtually impossible to produce a model that would have predictive power under different economic assumptions. Hence, Street models were inaccurate in 1996 and even more so in 1998. A prepayment model estimated around 1999/2000 had sufficient data to capture some of the more fundamental characteristics of prepayments. Unfortunately, most Street models continued to rely on antebellum explanatory variables and ignored the changing economic backdrop. In 1996, mortgage rates came within 50 basis points of 1993 levels; prepayments, however, were 20%-30% CPR slower. This could have been attributed to real home price depreciation and a flatter yield curve. Unfortunately, the slow speeds were most frequently attributed to "burnout". This had no predictive power as it was fit with a single observation. Such models were proven completely wrong in 1998 as the expected "burnout" failed to materialize.

Loan size was added to many prepayment models after the 1998 experience, as the fast speeds were in part attributed to larger loans. This was a significant improvement; however, the "media effect" was also used as an explanatory variable, which weakened the predictive power of models (as the effect lacked both economic motivation and sufficient data with which to reliably estimate). In 2001, prepayment models performed better, but still suffered from *ad hoc* media effects. Models using media effects had to be refit.

**Why should now be any different?**

In 2002, record low mortgage rates, a steep yield curve, and enormous home price appreciation combined to create the largest refinancing episode in history. For the first time, most Street prepayment models appeared to be too fast. After the sad history of prepayment modeling, it may seem a bit daunting to believe that a definitive model can ever exist. Extrapolating to unobserved economic conditions (and technological changes) will always limit predictive power. Nevertheless, we believe that there is now sufficient data to produce a model that is sensitive to the fundamental drivers of prepayments while offering reasonable predictive power under varied market conditions. To achieve our objectives we have, at times, sacrificed the quality of the "fit" when the data either appeared to be "noisy" or could not be explained by the variables at our disposal. In particular, this was the case for certain agency Alt-A "cohorts".

The JPMorgan prepayment model was estimated at the WALA level, using data from 1993 to the present for WALA buckets exceeding $200 million in outstanding balance. We allowed for small balances (to permit a wider variety of scenarios), but to minimize noise we weighted the data by the amount outstanding. In Exhibit 1, we show a few of the more salient historical features about the environment at origination. CATO is defined to be the slope of the curve at origination (2s/10s swaps), and CHPA is the inflation-adjusted cumulative home price appreciation (in percent). Since the environment at origination can be a major determinant of call risk, Exhibit 1 can be used as a rough guide to the characteristics of various cohorts.

**Exhibit 1: A decade of refinancing: Changing environment at origination**

| Orig year | Avg CATO (bps) | FNCR 30yr Avg | FNCR 30yr Low | 1yr CHPA | 5yr CHPA |
|---|---|---|---|---|---|
| 1993 | 200 | 7.1 | 6.5 | -0.7 | -0.5 |
| 1994 | 120 | 8.4 | 6.8 | -0.2 | -0.6 |
| 1995 | 60 | 8.1 | 7.2 | 0.7 | -0.3 |
| 1996 | 80 | 7.9 | 7.1 | 0.7 | 0.0 |
| 1997 | 45 | 7.7 | 7.1 | 1.8 | 2.4 |
| 1998 | 35 | 6.9 | 6.3 | 3.7 | 6.9 |
| 1999 | 50 | 7.4 | 6.6 | 3.4 | 10.7 |
| 2000 | 25 | 8.1 | 7.2 | 4.3 | 14.5 |
| 2001 | 150 | 6.9 | 6.1 | 5.5 | 20.0 |
| 2002 | 215 | 6.3 | 5.5 | 4.5 | 23.0 |

CATO = Slope of the swap curve at origination, CHPA = *Real* Cumulative Home Price Appreciation (net of CPI).
FNCR = Fannie Mae Commitment Rate (typically about 25 to 35bps below the rate offered to consumers).
Source: JPMorgan

# 2. Key Model Features

**The JPMorgan Model is distinguished by...**

- Self-selection captured through the incentive function. Implied borrower self-selection: CATO and SATO.
- Home price appreciation.
- No media effect (peak speeds captured with economic variables).
- Transparency of model inputs (CATO, SATO, loan size).
- Separate FNMA and FHLMC refinancing models.

### 2.1 Understanding and Defining the Economic Incentive

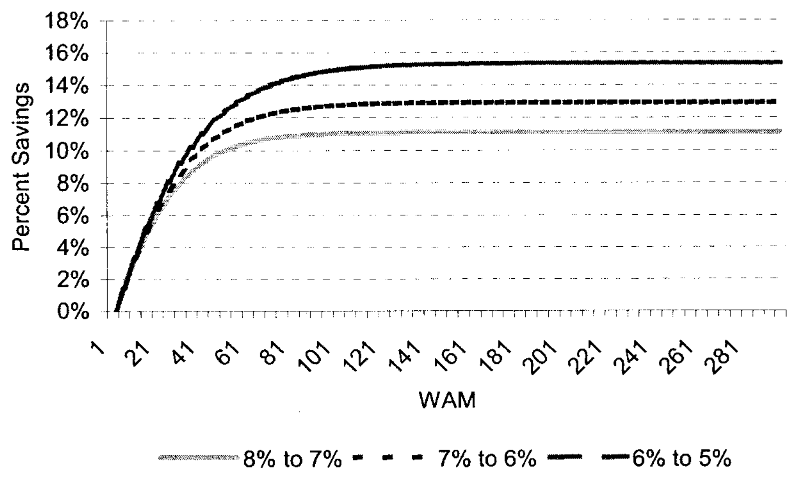
Perhaps the most important component of a prepayment model is the definition of incentive. In principle, if we fully understood the incentive of borrowers to refinance, we should be able to project prepayments for all large, homogeneous pools. Much of the complications that arise in prepayment modeling are from mis-specified incentives requiring compensating effects to match observations. In this section we discuss the refinancing incentive, focusing on how various economic and environment variables are incorporated.

**Economic incentive**

*We define our baseline economic incentive to be the percent savings.* [1]. There are two other frequently used incentives: the simple difference between the new and old rate, and the percent change in rates. The simple difference in rates is the least accurate; it dramatically misses the WAM and level dependence of the incentive. For example, simply using the difference in rates gives the same incentive between 8% and 7% as between 6% and 5%, but the percentage in savings is far greater for the latter. This is displayed in Exhibit 2, where we show the percent savings as a function of WAM for differing levels of rates (which would all have the same incentive if simply using the difference in rates).

[1] Percent savings is defined as the percent change in the present value.

**Exhibit 2: Percent savings as a function of WAM and level of rates**




Source: JPMorgan

Using a ratio of rates is a better proxy for the percent savings but still misses the WAM dependence of the incentive. Models that use the percent change in rates as the incentive will have too large an incentive for seasoned pools and, therefore, need a larger "burnout" function. This would be another example of how a mis-specified model requires the introduction of *ad hoc* effects; in this case, the introduction of excessive burnout. *In our view, the most difficult aspect of the incentive is not so much the functional form (which should be percentage of savings), but the rate and amortization type available to the borrower and the change in the environment since origination of the loan (curve, home prices, etc...).* The latter is where we will focus the majority of our attention.

### 2.2 Self-selection Provides Clues to the Refinancing Incentive

**Borrower self-selection**

The idea is that borrower self-selection in different interest rate environments provides modelers with important clues as to the future prepayment behavior. The most easily observed borrower self-selection is the choice of amortization type. This decision is primarily influenced by the shape of the yield curve and the borrower's horizon. In a flat yield curve, mortgage rates are similar across amortization types, leading to increased 30-year production (to retain the greatest refinancing option). Ceteris paribus, such originations should display the highest call risk. Thirty-year originations in a flat curve environment should display a high level of reactivity to a steep curve, as borrowers refinance down the curve. This effect is captured by making the market rate in the model depend on the *change* in the slope of the yield curve since origination of the mortgage (CATO). Therefore, 30-year paper originated in a steep curve should be significantly less callable than if originated in a flat curve environment.

The flip side of the argument is that shorter duration mortgage originations in a steep curve should be more callable relative to similar mortgages originated in a flat yield curve environment. There may also be less extension on short-duration mortgages (originated in a steep curve) as rates rise and the curve flattens. In contrast, thirty-year MBS originated in a steep curve could display greater extension in a bear flattener as the borrowers indicate a longer horizon by having opted for 30-year MBS in a steep curve.

Another useful indication as to future call risk is the difference between the rate a borrower obtains and the market rate. This is commonly referred to as SATO (or spread at origination), and is defined to be the difference between the WAC of the mortgage and the average WAC of the pools originated in the same month. The third economic environment variable is home price appreciation. This drives the turnover seasoning ramp and the absolute level of turnover. This factor can also mitigate the impact of burnout. We discuss these points further in later sections.

# 3. Curve at origination (CATO)

**A lesson from recent refinancing experience: Yield curve at origination**

Recent refinancing data has reinforced the relevance of changes in the yield curve on prepayments. The data has highlighted the relevance of the curve at origination on the callability of a pool. It is an important explanatory variable that allows the JPMorgan model to closely match speeds on 2000 and 2001 originations as well as capture the refinancing "seasoning ramp" without resorting to *ad hoc* factors such as the media effect or a static, non-economically motivated, aging ramp.

Explaining and predicting the evolving WALA dependence of prepayments was one of the more important objectives of the model. Traditionally, this has not been explained but rather fitted by a static refinancing aging ramp. It has, consequently, been a persistent problem affecting the predictive power of many prepayment models, requiring re-estimation with every refinancing wave. As we discuss below, the refinancing aging ramp has been far from static.

**Defining CATO...**

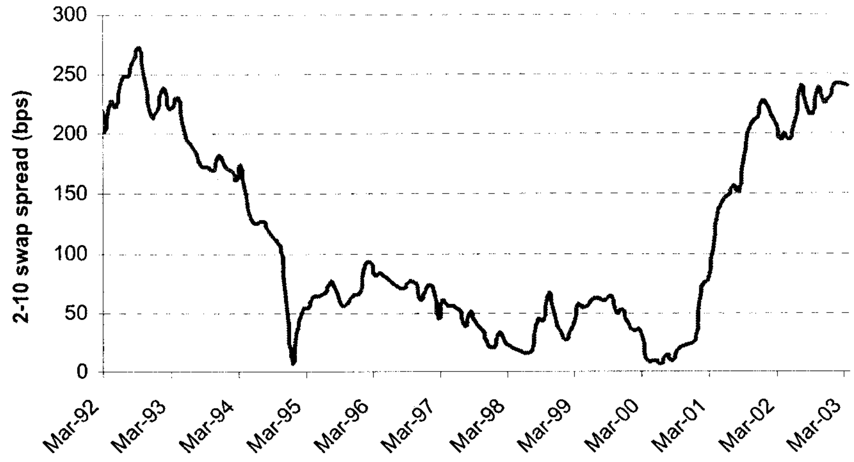
We define the curve at origination (CATO) as the spread between 10- and 2-year swap yields. This variable is used to project the impact of the yield curve on prepayments. Depending on the environment at origination a mortgage pool will display different reactivity to the current yield curve. *In the JPMorgan model it is the change in the yield curve since origination that is the predictor of the curve dependence of the refinancing incentive.* Most prepayment models have refinancing driven by the *current* yield curve (not by the change in the curve). This is incorrect and an example of "fitting" a model without regard to economic fundamentals. The curve at the origination of a pool defined the choice of available terms and amortization types. In most cases, only a change in the curve should lead to an increased transition rate between fixed and ARM mortgages.

**An explicit example: Comparing prepayments on 2000 and 2001 originations**

For example, 2000 originations appeared far more callable in late 2001 than have 2001 originations in 2002. The 2000 fixed-rate cohorts had a few factors working against them, making them more callable. First, the flat yield curve implied that borrowers did not have a meaningful incentive to take a hybrid loan. Secondly, the flat curve led to narrow coupon swaps, which in turn led to higher levels of excess servicing and likely greater WAC dispersion at the pool level. [2] Finally, 2000 originations had a higher purchase and cash-out concentration, implying longer horizons and a greater inclination to refinance.

[2] For example, from April–September of 2000 the average up-in-coupon swap (up 50bp from par) was only about $1-17, while in the second half of 2001 it was $1-29. Also, servicing multiples were around 7 in 2000 and only 4 in 2001, further inducing originators to retain a higher amount of excess servicing and originate lower coupons at higher WACs.

**Exhibit 3: The curve at origination: Virtually no Hybrid incentive in 2000**



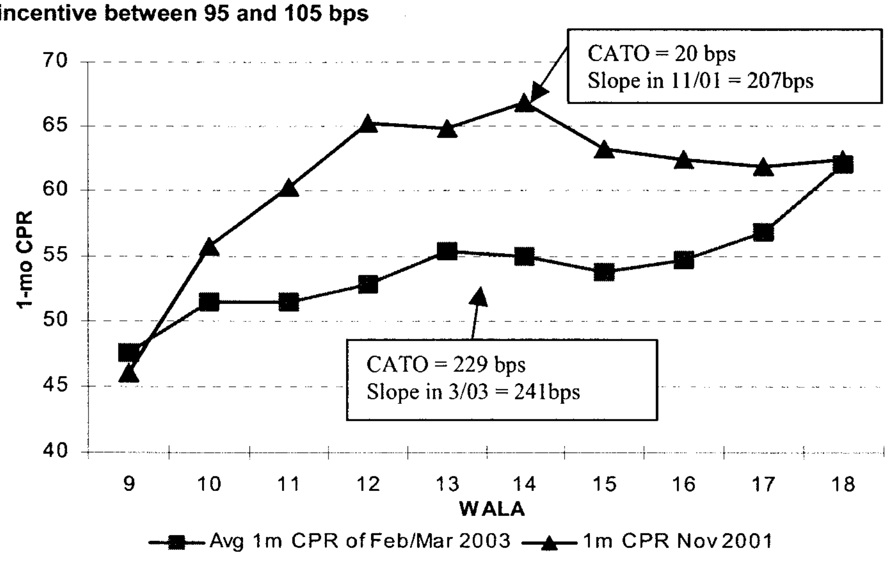

Source: JPMorgan

**... some empirical support ...**

**... "refinancing aging ramp" explained through CATO**

In the fall of 2001, as mortgage rates rallied and the yield curve steepened, hybrid ARMs became a more attractive option for mortgages originated in late 2000 and early 2001. The 11-15 WALA originations in the fall of 2001 had CATO of only 20bps (originated in a relatively flat curve). These cohorts were the most responsive to the steeper yield curve in the fall of 2001. In Exhibit 4, we compare the prepayments on 11-15 WALA paper in the fall of 2001 and in Q1 2003. In order to make the comparison meaningful, in both cases the prepayment data was for pools with refinancing incentives between 95 to 105 bps (as defined by the WAC minus average survey rate in the prior month). In 2003, the 11-15 WALA paper had a CATO of 229 bps and was far less reactive to prepayments than similar WALA paper in 2001 (which only had a CATO of 20bps). Thus, through CATO, the JPMorgan prepayment model captures the evolution of the refinancing aging ramp, without the need for a static seasoning ramp. This adds significant predictive power.

**Exhibit 4: Prepayments by WALA in Feb/Mar 2003 and Nov 2001 for FNMA pools with incentive between 95 and 105 bps**



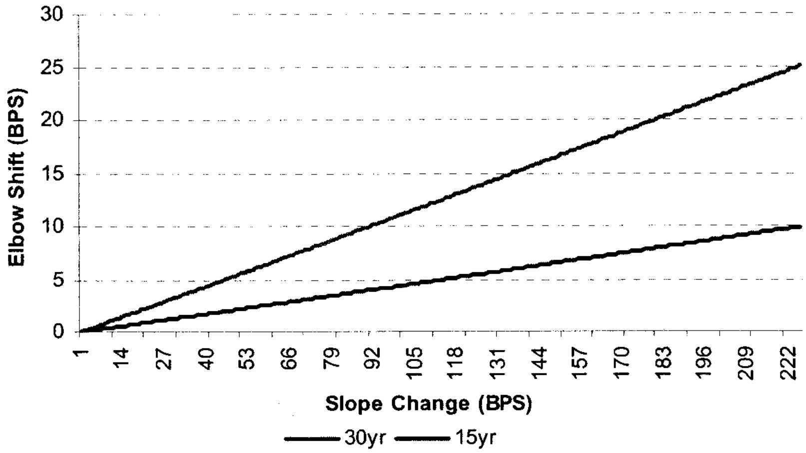

Source: JPMorgan, FNMA

**Implementation of CATO through the incentive...**

CATO is incorporated in the JPM prepayment model through adjustments in the refinancing incentive based on the change in the yield curve since origination. In Exhibit 5, we display the increased incentive (shown as a positive elbow shift) for given changes in the slope of the swap curve. The swap curve slope changes are defined by the current 2s/10s slope minus the slope at origination (i.e., CATO). We observe that in the 30-year conventional model the incentive can change by as much as 25-30bps. This roughly translates to 7%-10% CPR for cuspy coupons. The CATO impact in the 15-year conventional model is about 40% of the 30-year.

**CATO effect for 30-year and 15-year conventionals**

**Exhibit 5: Incentive increase due to change in curve slope since origination (slope defined by 2s/10s swaps)**

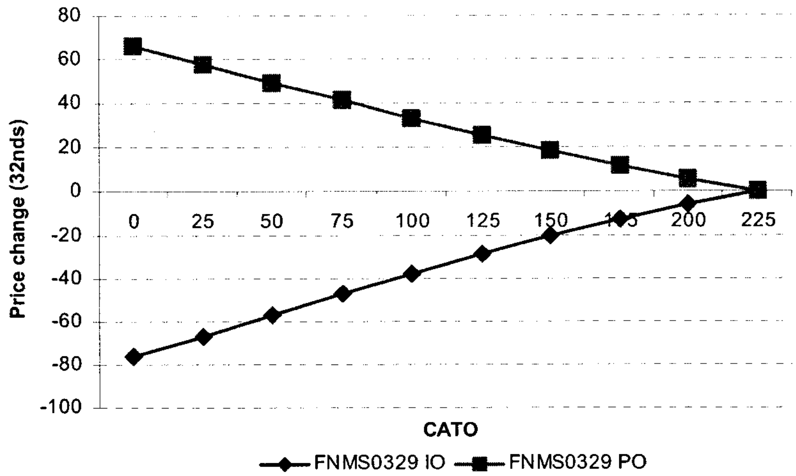



Source: JPMorgan

**Impact of CATO on FNS 329 IO/PO prices**

The impact of CATO can be observed most clearly for IO/POs. As an example, we consider FNS-329 IOs/POs. This is a Trust off new 30-year 5.5s. The CATO for this Trust is 225bps (slope of curve at origination). In Exhibit 6, we display the price impact (at constant OAS) of differing CATO assumptions. This was run using closing prices on 3/31/03, with the current coupon yield just over 5% (and FN 5.5 TBA as 102-04 for 4/14/03 settle). The slope of 2s/10s is currently 248bps, or only slightly steeper than at the origination of the FNS-329s. The Exhibit shows the projected price changes on the IO/PO for varying CATO assumptions. If the Trust were originated in a flat yield curve (0 CATO) the value of the IO would have been almost 2.5 points less due to increased risk of refinancing down the curve.

**Exhibit 6: Implied price changes for Long WAM 5.5% IO/POs by varying CATO (as of 4/2/03)**




Source: JPMorgan

# 4. Spread at origination (SATO)

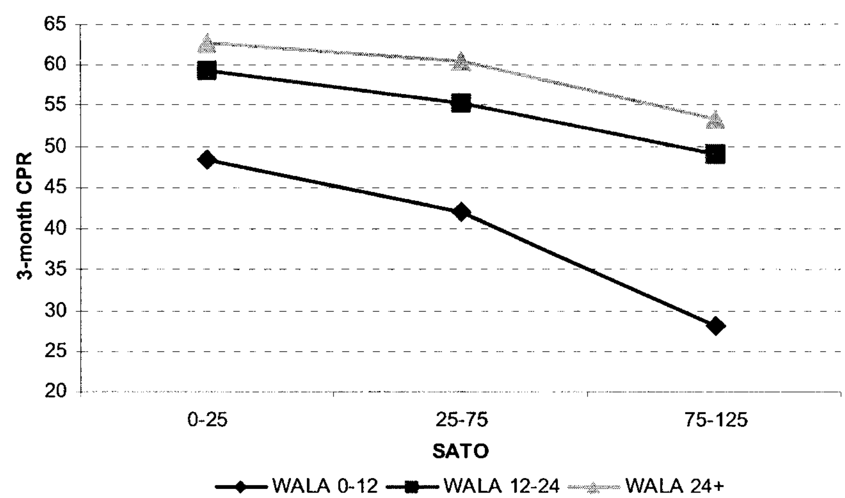
**Various non-standard collateral characteristics are captured through Spread at Origination (SATO).**

The JPMorgan prepayment model relies heavily on available information on loan characteristics and "self-selection". Consequently, the spread between the WAC on a pool and the average WAC of all pools at origination plays an important role. This difference in rates is referred to as the "Spread at Origination" or SATO. This spread is typically positive when there are non-standard loan characteristics (Alt-A), such as low documentation, investor properties, high LTV and/or low FICO. Typically, for agency Alt-A paper FICOs tend to be relatively high. Agency Alt-As are usually distinguished by low documentation, investor loans, and to a lesser extent high LTV. Effectively, high SATO is a proxy for some of these loan characteristics. Negative SATO indicates above average points paid. SATO is an important explanatory variable for agency prepayments that allows the JPMorgan model to more accurately project speeds on low WALA originations.

The new refinancing data in 2001/2002 has allowed us to estimate the impact of SATO. The high SATO pools initially display a muted response to refinancing opportunities. In time, however, some credit curing takes place and prepayments reflect more efficient responses. Our objective is to capture the "credit curing ramp" and the reactivity after curing. In Exhibit 7, we show the impact of SATO on prepayments for different seasoning profiles. The refinancing incentive was fixed at 100-175 bps. The data in Exhibit 7 supports the claim that high SATO originations partly cure over 12-24 months. However for SATOs above 100bps, even when fully cured, the speeds do not appear to catch-up with low SATO pools.

**Empirical support for the impact of SATO**

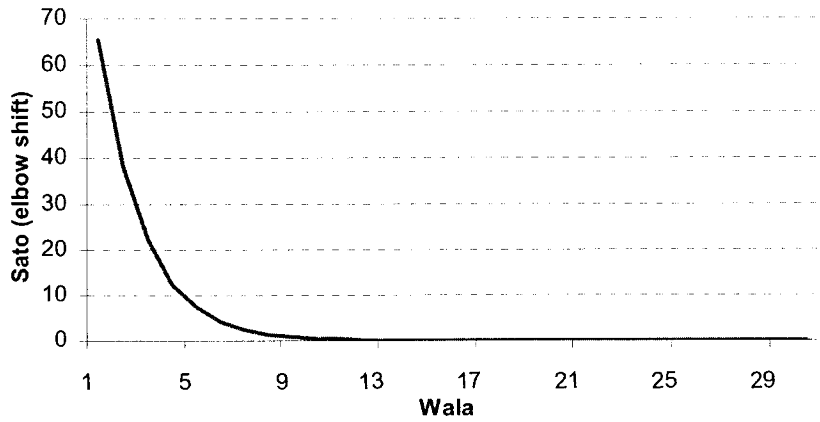
**Exhibit 7: FNMA 30-year prepayments (100-175bps incentive) by SATO in March 2003 for relevant WALA buckets**




Source: JPMorgan, FNMA

**Impact of SATO on incentive**

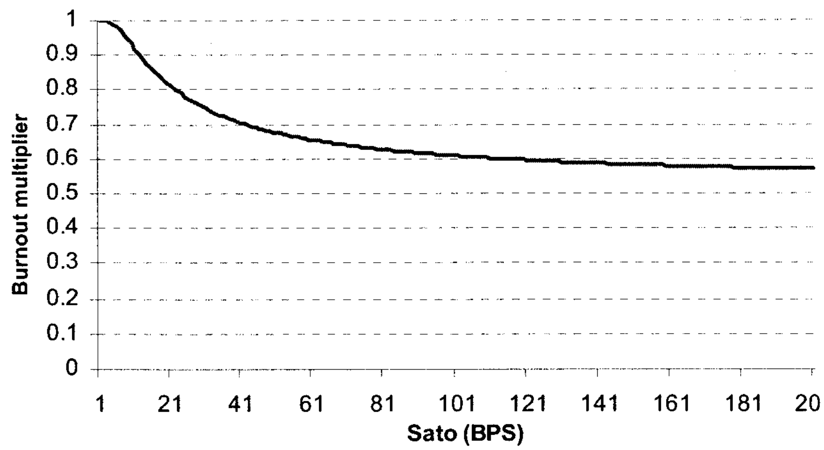
**Exhibit 8: Incentive adjustment (elbow shift) for 100bps of SATO**




Source: JPMorgan

**Even when fully "cured", high SATO loans display some "burnout"**

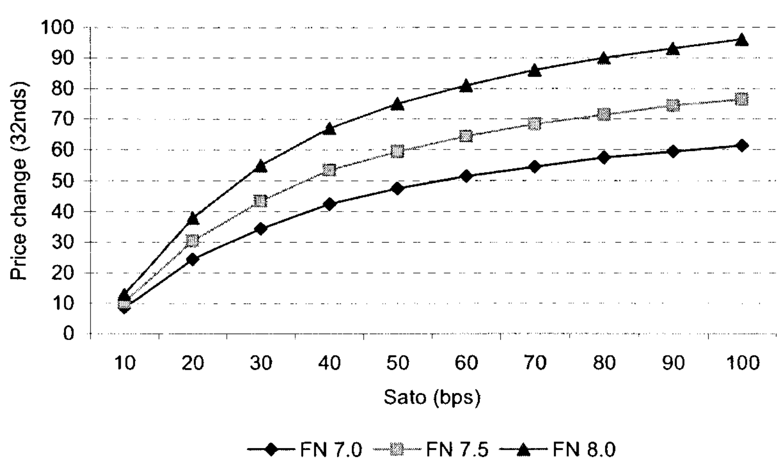
**Exhibit 9: Long-term prepayment constraints due to SATO**




Source: JPMorgan

**Impact of SATO on collateral**

**Exhibit 10: Projected constant OAS price changes for increasing SATO values on collateral (as of 4/11/03, with the current coupon at 5.095%)**




Source: JPMorgan

# 5. Impact of Loan size

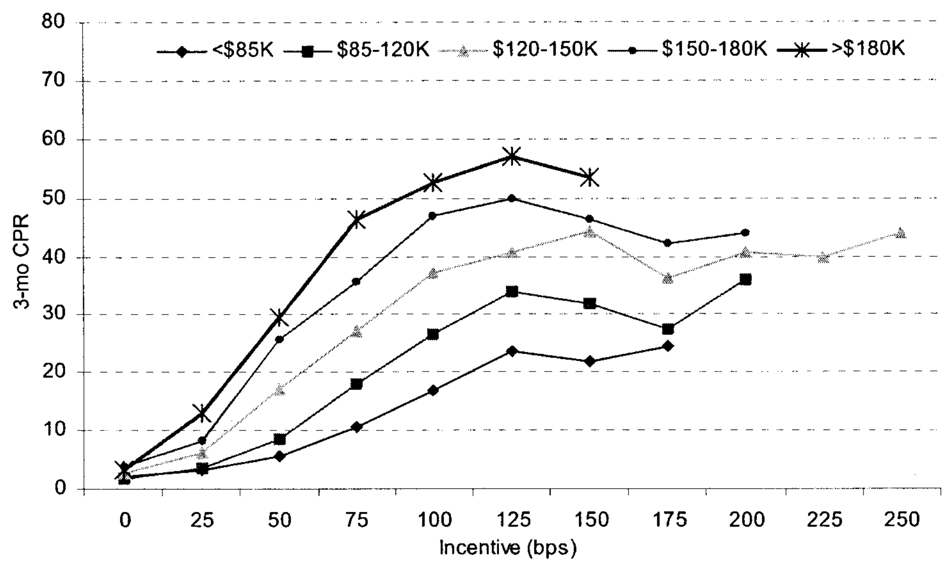
**5.1 Overview of the impact of loan size. We consider 30- and 15-year conventionals.**

**Overview**

We examine the impact of loan balance on prepayment speeds and find that it is as pronounced today as it was two years ago. Indeed, we find that for new originations the impact appears more pronounced, as the larger loans show higher call risk. The call risk on low loan balances appears the same as in 2001. A similar pattern can be observed in Jumbo loans, where the "super" Jumbos are prepaying much faster in 2003 than in the 2001 refinancing wave. At 100bps of rate incentive, conventional 30-year speeds increase by 5% to 10% CPR for every $30,000 increase in loan balance. However, the relationships for conventional 15-years and GNMA 30-years are not nearly as tidy.

**Conventional 30-years: Prepayments by original loan balance for recent originations**

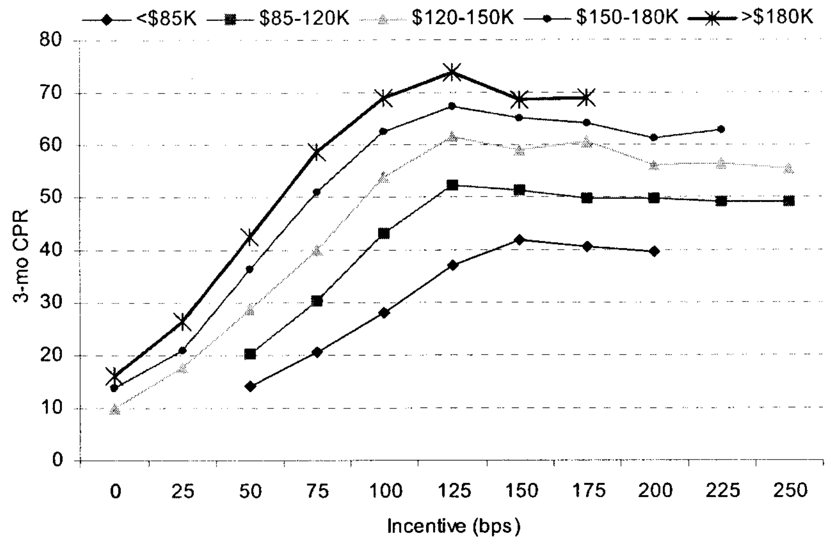
**Exhibit 11: February 2003 prepayments on 2002 Conventional 30-years**




Source: JPMorgan, FNMA, FHMLC

**Prepayments on 2001 vintage by loan balance**

**Exhibit 12: February 2003 prepayments on 2001 conventional 30-years**

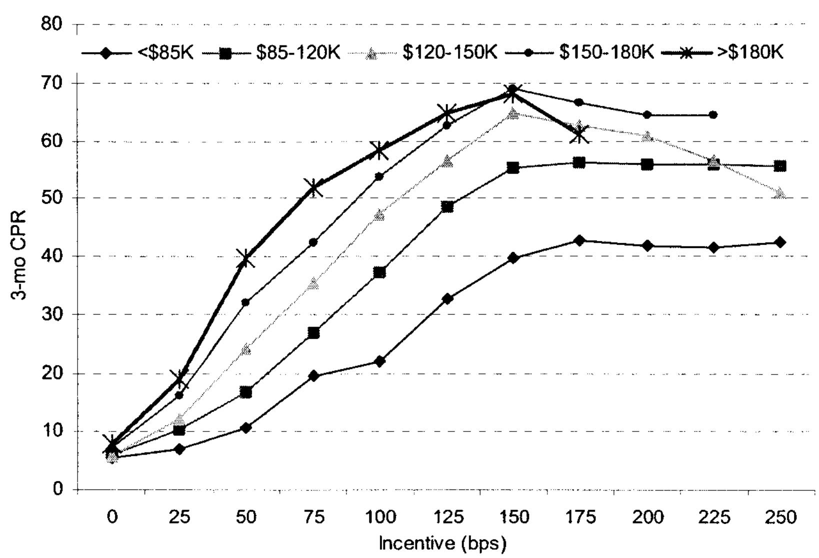



Source: JPMorgan, FNMA, FHLMC

Current prepayments on conventional 30-years originated in 2001 are faster than those originated in 2002, by approximately 10% CPR across all incentives. This is due to the combination of a steeper curve in 2002 (CATO effect) and higher turnover levels on the more seasoned paper.

**In 2001, 2000 originations showed prepayment convergence for loans above $120,000**

**Exhibit 13: December 2001 prepayments on 2000 conventional 30-years**

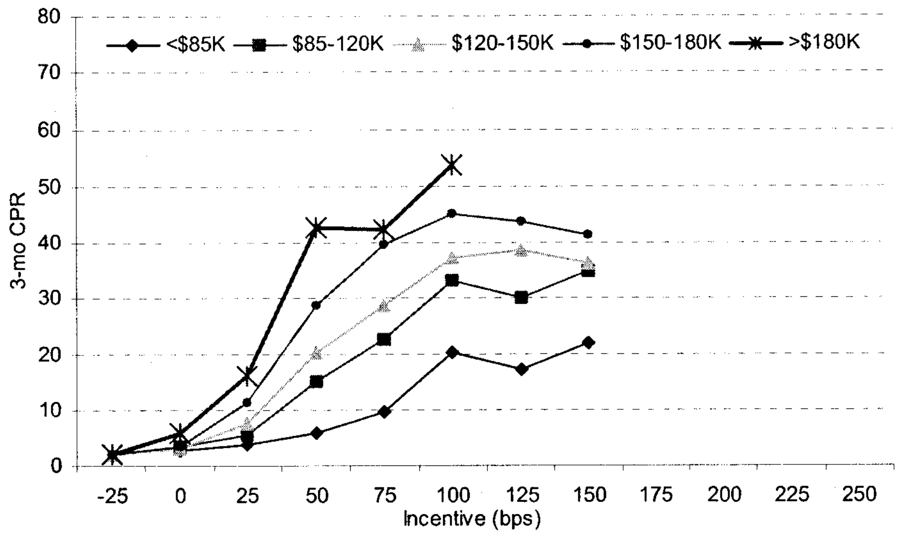



Source: JPMorgan, FNMA, FHLMC

As is evident, the impact of loan balance is presently greater for both 2001 and 2002 originations than it was for 2000 originations in 2001. This is due primarily to the currently greater reactivity of the largest loans. A similar effect can be observed in Jumbo collateral, where super Jumbos are now showing far greater prepayment reactivity than in 2001 (for similar seasoning).

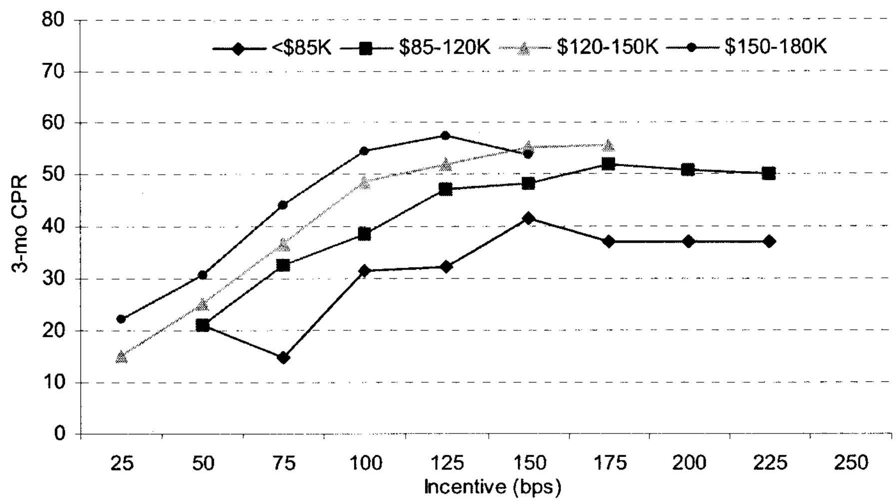
**Conventional 15-years display a lower dependence on loan balance**

**Exhibit 14: February 2003 prepayments on 2002 conventional 15-years**




Source: JPMorgan, FNMA, FHLMC

**Exhibit 15: February 2003 prepayments on 2001 conventional 15-years**



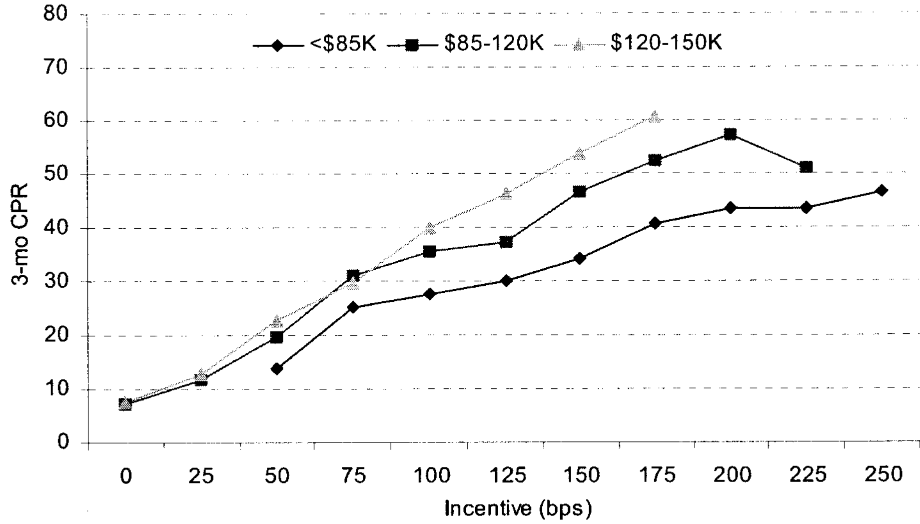

Source: JPMorgan, FNMA, FHLMC

**The dependence on loan size for 15-year pools is less well defined than for 30-years...**

For 15-year conventional pools, the effects of loan balance and incentive on speeds are currently not as well defined as for 30-years. Pools with average loan sizes between \$85,000 and \$150,000 behave similarly. There are notable differences only for significantly larger and smaller average balances (see Exhibit 16). For balances above \$150,000 even small incremental incentives impact speeds. The less pronounced dependence on average loan size in 15-years is to a large extent due to the much narrower loan size distribution in the sector. There are relatively few 15-year pools with average loan sizes above \$150,000. However, this is changing rapidly. New Dwarf 4.5s and 5s have average loan balances of around \$155,000 and \$145,000, respectively. While conventional 30-year pools still have larger average loan sizes, that difference is becoming less relevant as the average loan sizes get larger. This could lead to convergence in call risk for new 30- and 15-year paper.

**...this is to a large degree because of the narrower loan size distribution in 15-years**

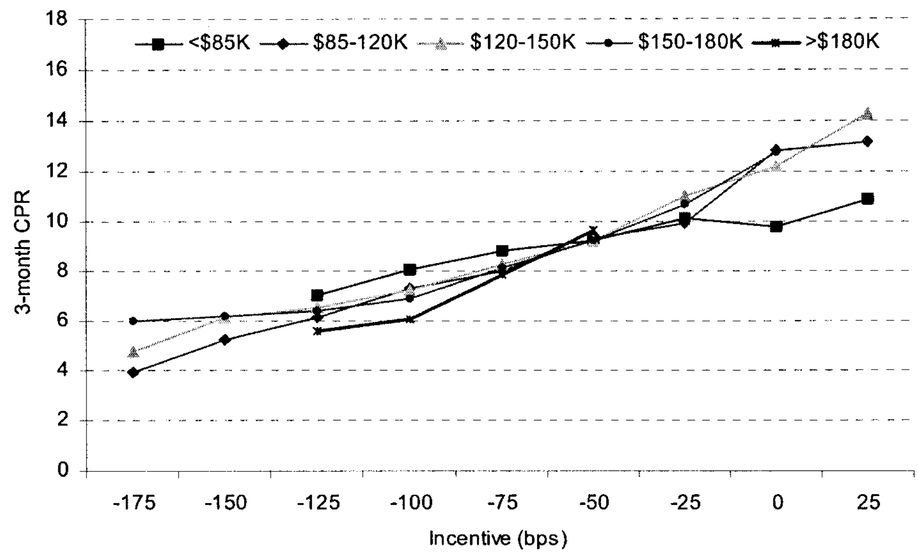
**Exhibit 16: December 2001 prepayments on 2000 conventional 15-years**




Source: JPMorgan, FNMA, FHLMC

**Examining the behavior of low loan balance pools in a discount environment (i.e., in 2000)**

**Exhibit 17: December 2000 prepayments on 1998 conventional 30-years**

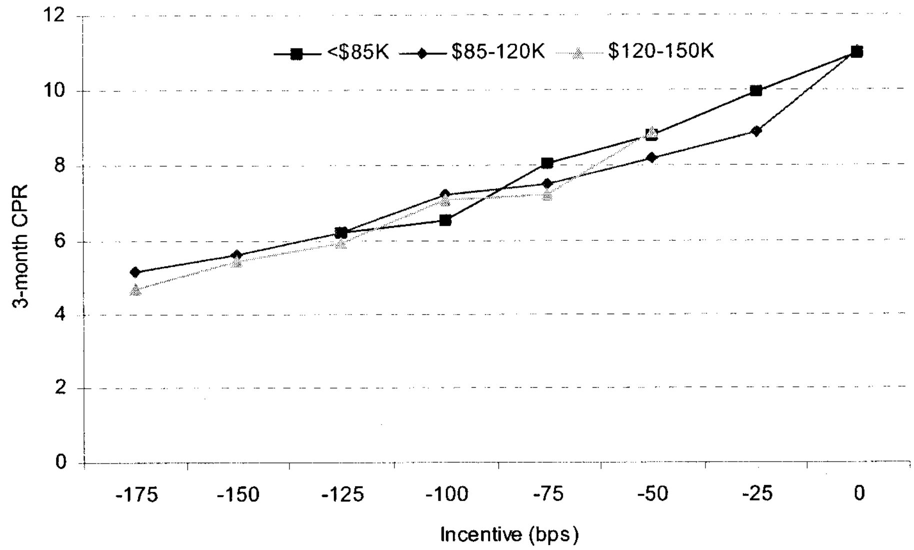



Source: JPMorgan, FNMA, FHLMC

With relatively high rates in December 2000, nearly all 1998 originations were out-of-the-money. This period is therefore suitable for examining the behavior of low loan balance pools in a high rate environment. Under these circumstances there is clear evidence supporting faster turnover speeds on smaller loans. In particular, in 2000 30-year loans with balances below $85,000 prepaid about 2% CPR faster than loans with balances above $180,000 when about 100bps out-of-the-money. This was in a relatively strong housing market, where extension on large loans was mitigated by strong home equity. For 15-years (see Exhibit 18), low loan balances do not appear to offer superior extension protection. The LTVs on 15-years are generally lower than for 30-years and larger loans exhibit relatively limited lock-in.

**Low loan balance 15-years do not appear to offer superior extension protection based on 2000 data...**

**Exhibit 18: December 2000 prepayments on 1998 conventional 15-years**



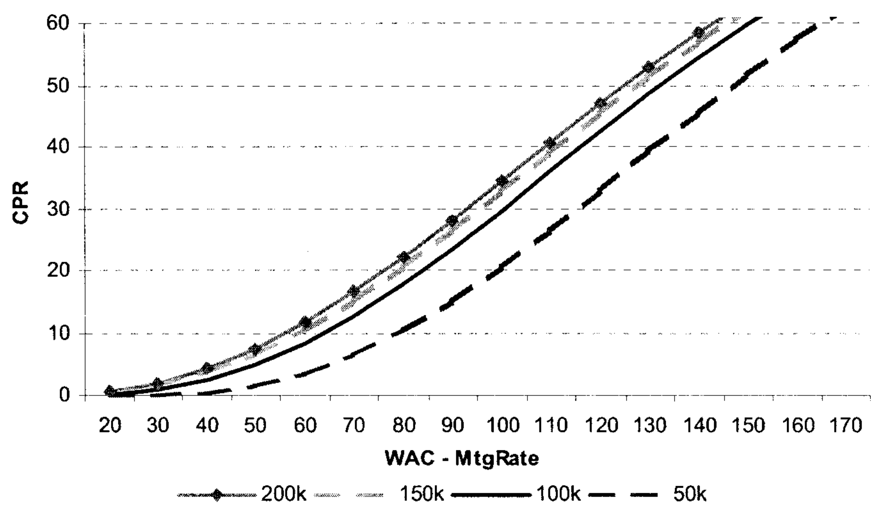

Source: JPMorgan, FNMA, FHLMC

## 5.2 Impact of loan size in the JPMorgan Prepayment Model

In Exhibits 19, 20 and 21 below, we show the impact of loan size on conventional 30-year speeds, TBA prices and option costs in the JPMorgan prepayment model. The impact is most pronounced for loans below $100,000. It is modeled by altering the incentive based on the loan size. Therefore, for a large enough rate incentive the model projects some convergence in speeds.

**Impact of loan size on model prepayment speeds**

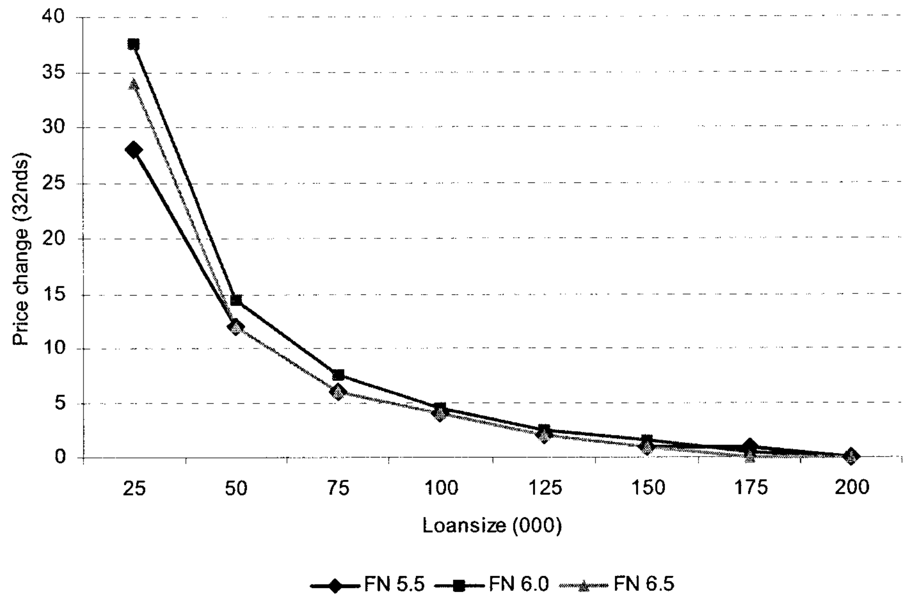
**Exhibit 19: Examples of Conventional 30-year S-curves for different loan sizes**




Source: JPMorgan

## Impact of loan size on price, assuming a baseline TBA loan size of $200,000

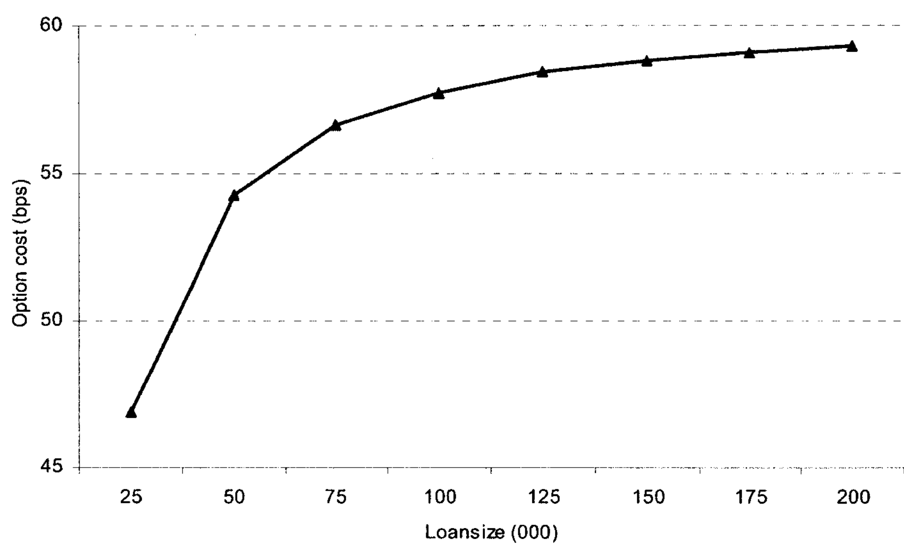
**Exhibit 20: Loan size impact on FNMA 30-year collateral prices assuming a constant OAS (as of 4/11/03, with current coupon at 5.095%)**




Source: JPMorgan

## Impact of loan size on option cost

**Exhibit 21: Loan size impact on FNMA 30-year 5.5s option cost (as of 4/11/2003, with current coupon at 5.095%)**




Source: JPMorgan

# 6. Home Price Appreciation

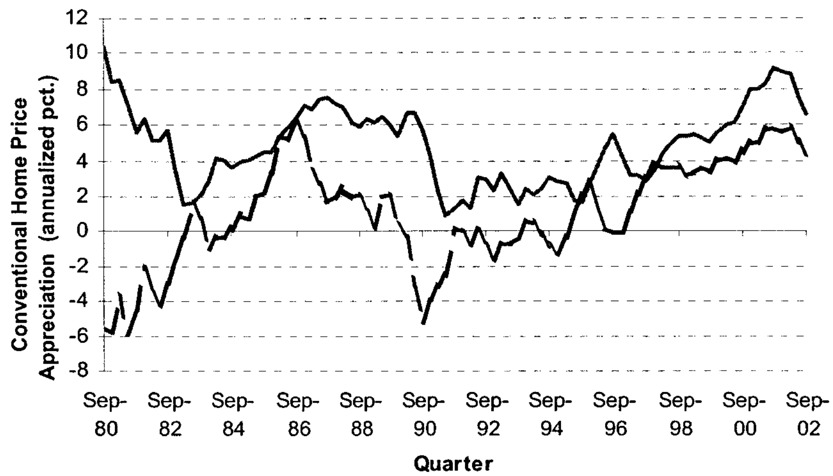
**Home price appreciation's role in prepayments**

We believe that there is now sufficient prepayment data over varying housing markets to be able to effectively incorporate home price appreciation in the prepayment model. In our view, the impact of the housing market is primarily through turnover seasoning, equity-take-out and the curing of "burnout". As we discuss in more detail in Section 8 (Turnover Model), in the JPMorgan model equity-take-out (which has only weak interest rate dependence) is incorporated in the "turnover" component of the model.

**Cumulative home price appreciation (CHPA) drives the turnover seasoning ramp and the "lock-in" effect.**

The turnover seasoning ramp can easily be shown as a strong function of inflation-adjusted ("real") cumulative home price appreciation. The seasoning ramp can vary from as short as a year (for exceptionally strong housing markets), to as long as six years (in depreciating or flat housing markets). Home price appreciation not only impacts the rate of seasoning but also long-term turnover levels. Hence, a strong housing market can mitigate the impact of lock-in.[3] The estimation period for the model was from 1993 to the present. During this time, there was an episode with low turnover levels (significant lock-in) following a weak housing market (1994), and another with accelerated turnover levels following a strong housing market (2000).

**Exhibit 22: Home price appreciation over the past 20 years**




Source: JPMorgan, FHLMC

[3] "Lock-in" refers to the rate dependence of non-refinancing driven prepayments. In particular, the additional slowdown in prepayments as loans move further out of the money.

Over the last five years real home price appreciation has been running at around 4%-5% a year. In our OAS framework we allow for different assumptions as to the future projection of housing appreciation. Our conservative projection is for a 1% annualized rate of real home price appreciation which would be in line with long term historical data.[4] Given the current shape of the yield curve, the assumption of a weaker housing market leads to narrower OAS and longer durations for most pass-throughs.

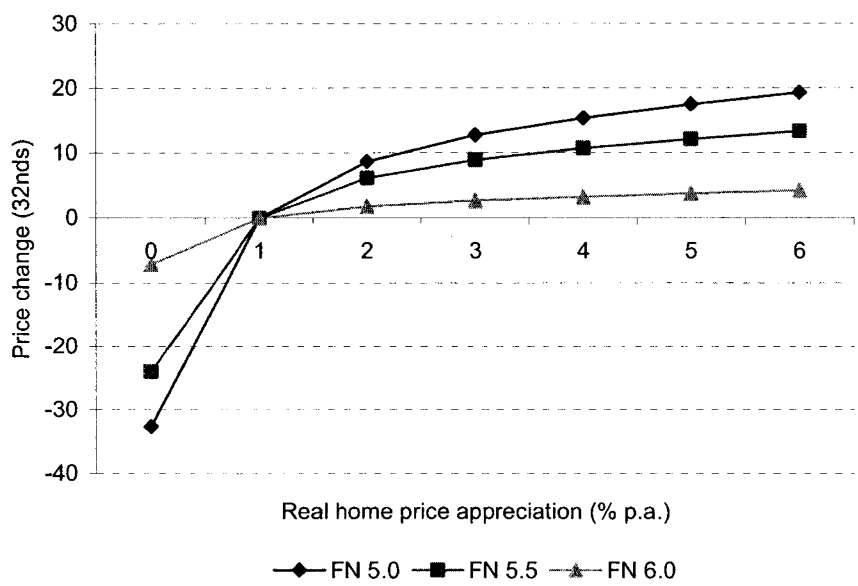
**Quantifying the impact of projected home price appreciation on pass-throughs.**

A strong housing market mitigates the extension risk but also lowers the value of seasoned premiums by curing burnout. Using the JPMorgan prepayment model (and the assumption that previous relationships between prepayments and housing are sustained), we quantify the impact of projected home price appreciation on valuations and duration estimates.

**While projected home price appreciation has relatively little impact on 6s, it is a major driver of value in 5s and 5.5s.**

In Exhibit 23, we display constant OAS price changes on TBA pass-throughs under varying assumptions for projected real home price appreciation. It is important to point out that projected home price appreciation has relatively little impact on 6s but is a major driver of value on 5s and 5.5s. We assume a baseline projected home price appreciation of 1% per year in real terms. The difference between the 4% real HPA and the 1% projection implies a loss of about 10/32s in value on 5.5s (as they extend) or about 8bps of OAS. Our baseline assumption for slower home price appreciation also leads to longer durations.

**Exhibit 23: Price impact on 30-year MBS at different rates of home price appreciation and at constant OAS (as of 4/11/2003, with current coupon at 5.095%)**



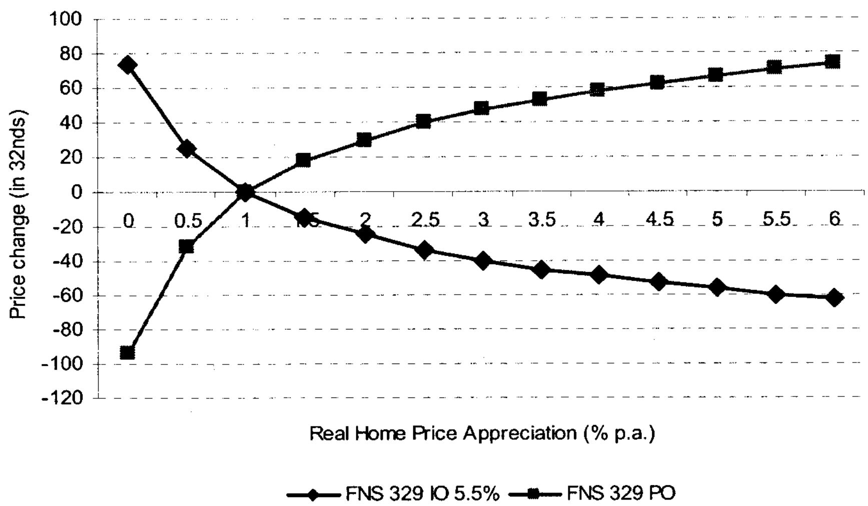

Source: JPMorgan

[4] There is little historical data supporting any correlation between real home price appreciation and the level of rates.

### Examining the case of 5.5s IO/POs: More levered views on housing

In Exhibit 24, we look at the impact of home price appreciation on IOs and POs (under constant OAS assumptions). We consider Trust 329s for our analysis, a new trust backed by 30-year 5.5s. This Trust is the most sensitive to projected home price appreciation. Generally speaking, a strong housing market is adverse for IO valuations by leading to more rapid seasoning, high turnover and mitigated burnout. From Exhibit 24 we note that the difference on 5.5 IOs between a strong and weak housing market can be more than 4 points in valuation.

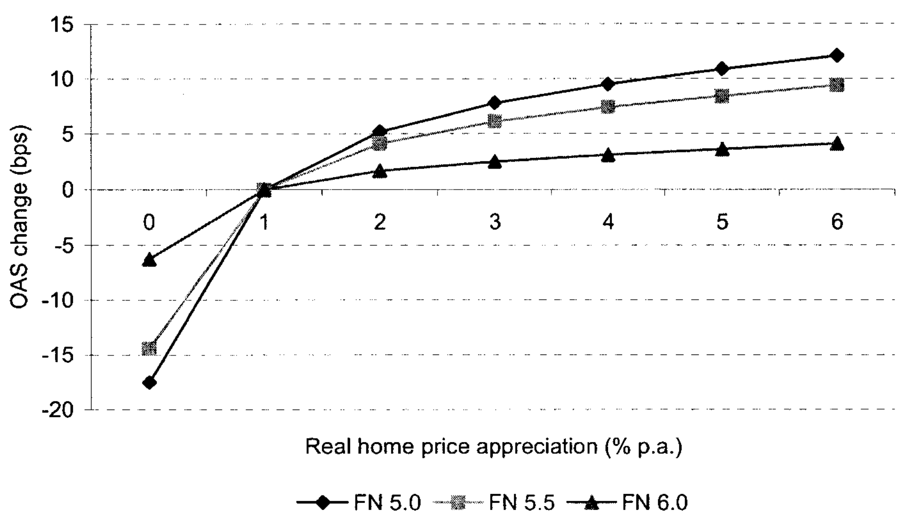
**Exhibit 24: Impact of home price appreciation on FNS 329 strips (as of 4/11/2003)**




Source: JPMorgan

In Exhibit 25, we display the change in OAS on TBAs due to varying assumptions on projected HPA. This is analogous to Exhibit 23. Again, we observe that FNMA 6s show less exposure to HPA assumptions relative to FNMA 5s and 5.5s.

**Exhibit 25: Impact of projected home price appreciation on OAS, as of 4/11/2003**

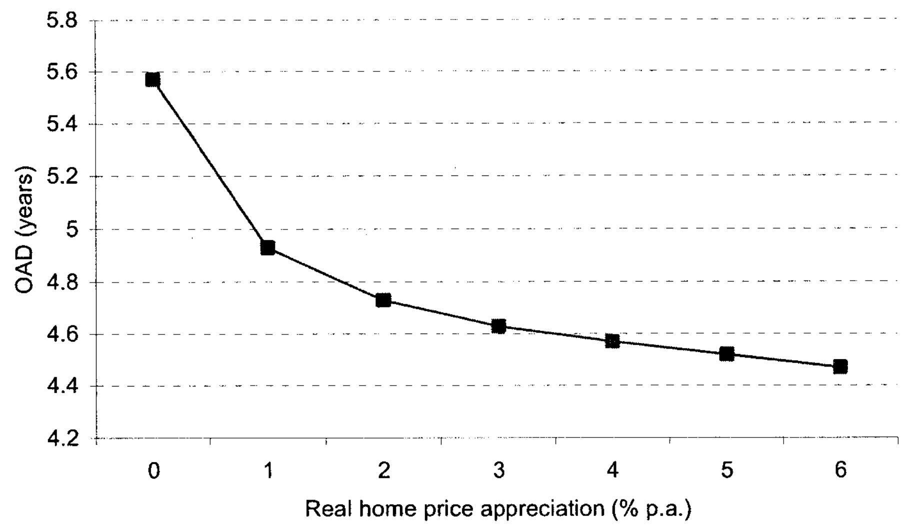



Source: JPMorgan

## Duration as a function of HPA

One of the more interesting results of incorporating HPA is its implications for duration. In Exhibit 26, we show the dependence of OAD on HPA for FNMA 5.5s. We note that the "current coupon" duration can vary from as long almost six years for a depreciating housing market to as short as four years for a rapidly appreciating market (using the yield curve as of 4/11/03). It should be noted that the duration numbers are also strong functions of the yield curve, with durations longer in a steep curve. For example, if the market starts pricing in a housing slowdown when the curve is flattening, the two effects may lead to partially offsetting duration moves.

**Exhibit 26: Duration on FNMA 5.5s (4/11/2003) is strongly dependent on projections for the rate of real home price appreciation**




Source: JPMorgan

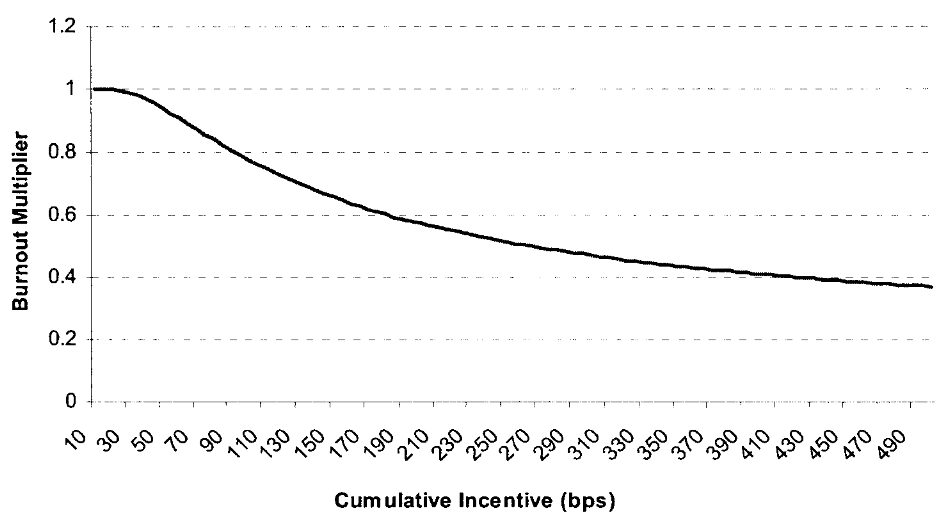
# 7. Burnout

"Burnout" is a part of prepayment lore and one of the more abused functions. It is, in principle, designed to account for the evolution of a pool of mortgages, capturing declining call risk on seasoned premium collateral. The problem is that without necessarily understanding the causes of "burnout" it can easily be misfit. The "perfect" prepayment model would not need burnout as it could be captured by the evolving incentive for a pool of mortgages. By using a relatively sophisticated incentive function, we have attempted to minimize the relevance of burnout in the JPMorgan Prepayment model. Nevertheless, some form of burnout was necessary for the 30-year prepayment model. In the 15-year model, prepayments were captured with virtually no need to incorporate burnout. As this may be a potential source of error in prepayment projections, we took great care in estimating burnout and allowing for curing. In Exhibit 27, we display the baseline burnout function for 30-year MBS. The burnout function acts as a multiplier dampening the refinancing function. It is a function of the cumulative incentive (defined as the weighted sum of the monthly present value of savings for a refinancing).

**Defining the cumulative incentive...**

The cumulative incentive requires some explanation. The monthly incentives are weighted by normalized functions of accumulated home price appreciation. The incentive weights decline with accumulated home equity. This follows one of the main themes of the prepayment model: capturing effects with the choice of economically motivated variables. This definition of the cumulative incentive makes it difficult to provide a simple graph of burnout, as much of the subtlety of the function is captured by the definition of weighted cumulative incentive. For example, assuming a 1% rate of real home price appreciation, 100bps of cumulative incentive (in Exhibit 27) can correspond to either 65bps of incentive for 12 months or 145bps of incentive for 6 months.

**Exhibit 27: Burnout is a monotonic function of weighted cumulative incentive**



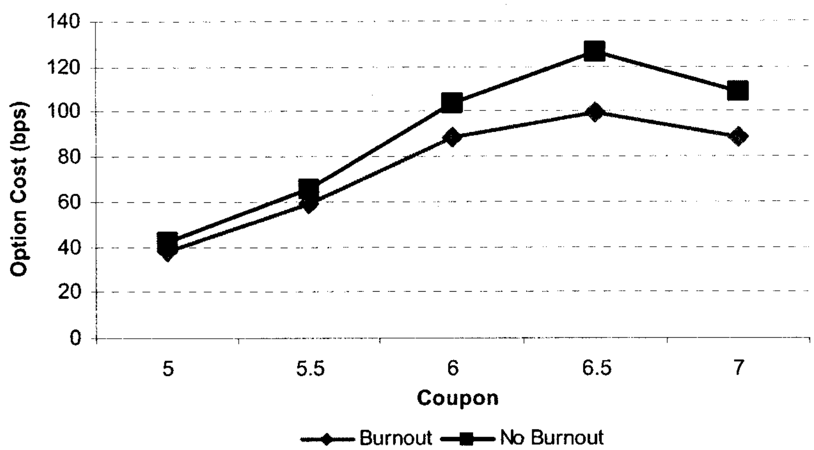

Source: JPMorgan

### Burnout on 1998 FNMA 6.5s

To provide a more concrete example we examine 1998 6.5s. The JPMorgan prepayment model has a burnout factor of 65% on the 1998 6.5s with a cumulative incentive of 156bps and a cumulative real home price appreciation of about 20% (with a nominal appreciation of 30%). This data is as of the end of February 2003. Despite the relatively high burnout, the JPMorgan model projects slightly over 68% CPR on 1998 FNMA 6.5s for March. The speed projection would have been in the high 80%s CPR if there were no burnout.

### Impact of burnout on option cost

**Exhibit 28: TBA Collateral option cost on 4/11/03 with and without burnout**




Source: JPMorgan

# 8. Turnover Model

**The components of our turnover model**

- Home price appreciation
- Seasoning ramp
- Lock-in
- Seasonality and calendar effects

The prepayment model is split into exclusively rate-driven prepayments (refinancing) and low rate sensitivity prepayments (turnover). In the "turnover" component we include home sales, defaults and equity-take-out. Many Street models incorporate "equity-take-out" in the refinancing function; however, equity-take-out is driven more by accumulated home price appreciation than the level of rates. We therefore fitted the turnover component of the model using prepayment data on mortgages with no rate-driven refinancing incentive. We used data going back to the early 1990s.

**The building blocks**

The turnover model is constructed around a baseline prepayment rate and seasoning ramp driven by cumulative home price appreciation. The baseline speeds are also weakly influenced by the "disincentive" to refinance; this is referred to as lock-in. Over the last decade there have been enough episodes of deeply out of the money mortgages in both strong and weak housing markets to be able to effectively fit the turnover function. Besides these basic variables monthly turnover also has a cyclical seasonal component.

**Seasoning ramp**

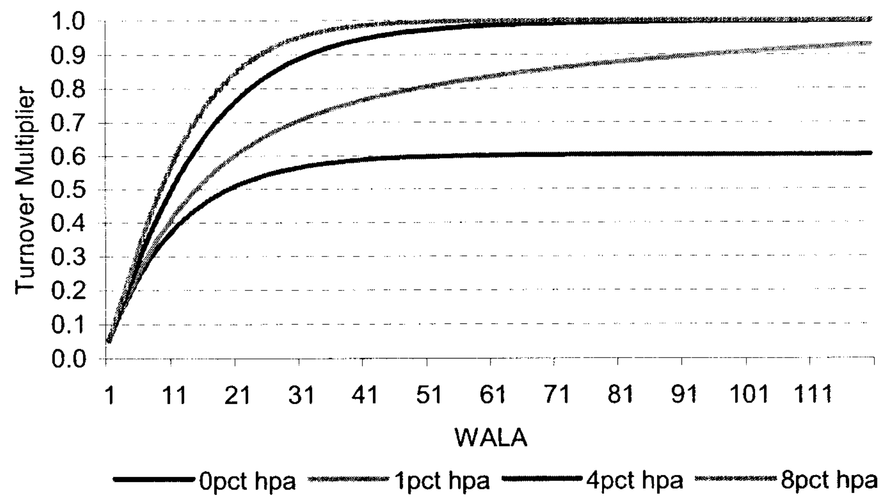
While the turnover seasoning ramp may appear innocuous, it has been a major factor in recent valuations of MBS. The strong housing market and an increasing share of refinancing originations have led to shorter turnover aging ramps. When combined with a steep yield curve, a shorter ramp can significantly boost valuations and shorten durations. It is therefore extremely important to understand the variables driving the aging ramp. We believe that there are two main factors: percent refinancing originations (or home tenure) and cumulative home price appreciation (or current LTV). This implies that the length of the aging ramp is not a stationary variable but rather intricately tied to the economic backdrop. Therefore, in calibrating the aging ramp we allowed it to vary based on home price appreciation. We did not use the percent of the mortgages that were refinancing originations. While this may be an important variable, the available data is not adequate to support this conclusion.[5] Home price appreciation alone seemed to be the primary explanatory.

In Exhibit 29, we display the conventional 30-year turnover aging ramp as a function of cumulative home price appreciation. The graph is against a multiplier of the baseline prepayment rate. *The baseline turnover level is also driven by the housing market.* The highest non-seasonally adjusted turnover level allowed in the JPMorgan model is 14% CPR (in exceptionally strong housing markets). There are no model limits on how slow speeds can get in a real depreciating housing market. In a flat housing market, the long-term model turnover is around 7% CPR.

[5] In June of 2003, FNMA and FHLMC are scheduled to release data on the share of refinancing originations at the pool level. This issue will be revisited at that time; however, anecdotal data leads us to believe that the refinancing share will not be as relevant as home price appreciation on the turnover seasoning ramp.

### Impact of HPA on the 30-year conventional turnover seasoning ramp

**Exhibit 29: Seasoning ramps under different HPA assumptions**



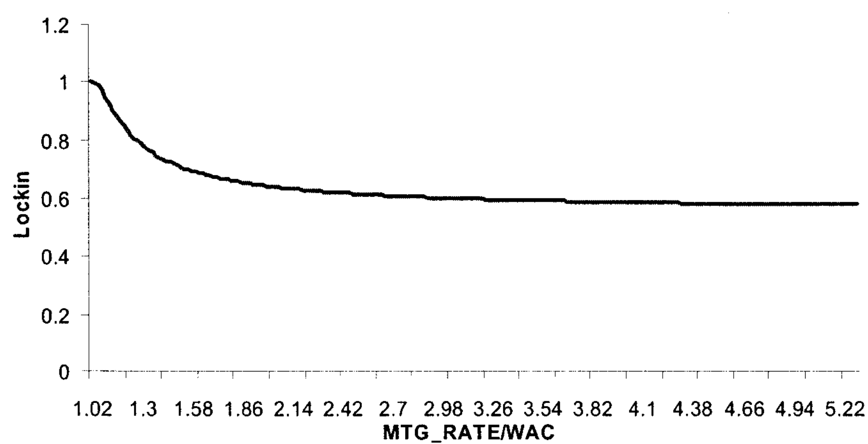

Source: JPMorgan

### Turnover lock-in

While turnover is estimated for mortgages with no refinancing incentive, it does have some correlation with the level of interest rates. For example, from 1993 through 2002, the correlation between turnover and interest rates was 65%. Through "lock-in" the model captures the weak correlation between mortgage rates and turnover speeds. As the amount of historical data is limited, it is important to separate the effect of "lock-in" from home price appreciation.[6] There are periods (such as in 1994) where both effects were in play. Capturing that period with only lock-in would overstate the impact. In Exhibit 30 we show the JPMorgan lock-in multiplier as a function of the ratio of current mortgage rate to the WAC on the pool. The actual function is not driven solely by the ratio of rates, but by the full disincentive function (which is also a function of seasoning).

### JPMorgan Lock-in multiplier…

**Exhibit 30: Baseline lock-in graph (no lock-in is defined to be 1.0)**



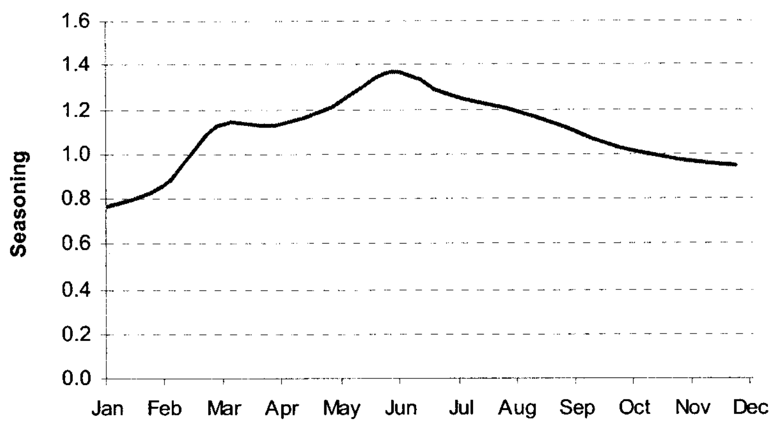

Source: JPMorgan

[6] There are two relevant historical periods for analyzing "lock-in": 1994 and 2000. These periods corresponded to weak and strong housing markets, respectively.

## Seasonality and calendar effects

Seasonal and calendar day effects play a meaningful role on turnover.[7] The number of business days in a month has an impact on monthly speeds, but the more relevant factor appears to be weather and school schedules. In Exhibit 31 we display the JPMorgan seasonality function, showing that peak turnover levels in June (40% higher than baseline) and the trough in January/February (at 20% below the baseline). At JPMorgan, the seasonality was determined from actual prepayment data rather than from home sales data. The standard algorithm is the X-11/12 ARIMA regressions, as used by the Census Bureau. We did not find any meaningful differences between the two approaches.

**Exhibit 31: The seasonality of turnover**




Source: JPMorgan, NAR

[7] Calendar turnover effects also impact refinancing.

# 9. Refinancing Model

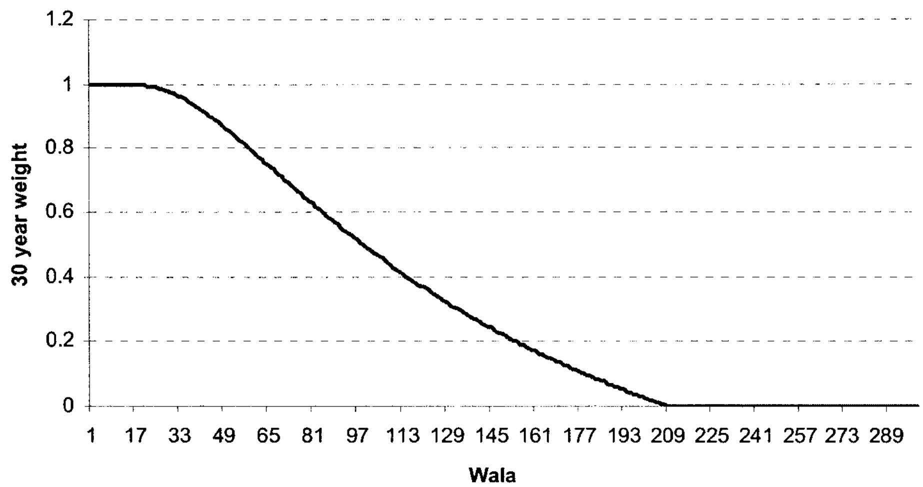
**After understanding the incentive, the refinancing model becomes very simple.**

The refinancing model is very simple once the incentive is understood: it is simply the S-curve. In the JPMorgan Prepayment model there is a single S-curve for each amortization type. However, while we have now discussed almost all of the components of the refinancing incentive, there does remain one last factor to consider: refinancing across amortization types. This primarily impacts seasoning; as a loan ages the borrower has increasing incentives to refinance into shorter amortization schedules. Because a borrower can curtail a loan, mortgage rates must always decline for shorter amortization periods; otherwise, there would be no reason for a borrower to take a shorter original amortization schedule. For instance, in an unchanged rate environment a 30-year loan after 15-years would have a refinancing incentive into a 15-year (which is a lower rate than the original 30-year). This effect is incorporated into the JPMorgan model by having the mortgage rate be a function of seasoning (i.e., borrowers incentive rolls down the mortgage yield curve as the loan ages).

**30 to 15 year incentive transition**

For simplicity, we display the mortgage rate as a blend of the 30- and 15-year rates with the weight shifting towards 15-years as the loan ages. In Exhibit 32, we show the weights for the 30-year mortgage rate as a function of WALA. The 15-year weighting is one minus the 30-year weight. The JPMorgan model uses 50% 30-year and 50% 15-year at 110 WALA and purely the 15-year mortgage rate at about 220 WALA. These results were determined empirically.

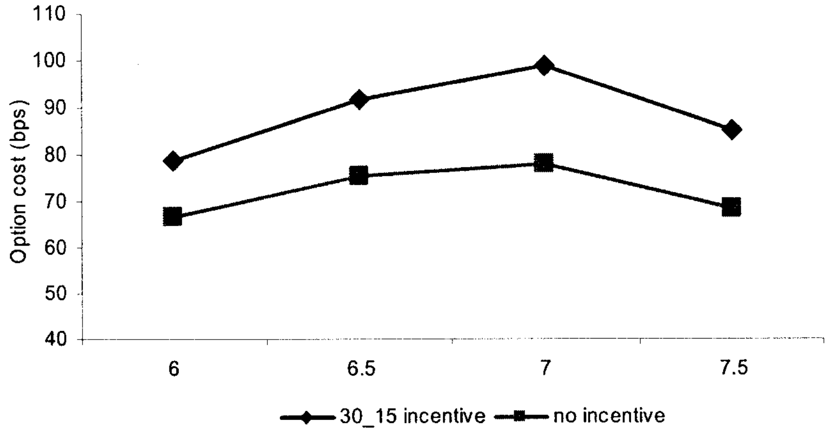
**Exhibit 32: 30-year mortgage rate weighting**




Source: JPMorgan

**Impact of 30-15 year incentive on 1993 originations**

**Exhibit 33: Collateral option cost for 1993 seasoned 30-year collateral as of 4/11/2003 with and without the 30-15 incentive adjustment**




Source: JPMorgan

**No media effect is needed...**

Traditionally, unexplained variables are attributed to the media effect in prepayment models. As rates reach historic lows, most models have a boost in prepayment speeds to capture the peaks. The JPMorgan prepayment model looks closely at the economics at origination and uses this information to capture peaks. There is no media effect in our model. There is also very little empirical data to support the existence of a "media effect". Fitting non-linear functions such as the media effect from sparse data seems inappropriate, especially when historical prepayment peaks can be explained entirely using an appropriate incentive function.

**... in fact, we slow our model down during heavy refinancing activity.**

Contrary to the standard "media effect", the JPMorgan model incorporates a capacity effect. When refinancing volumes are high, capacity constraints can limit peak speeds and lengthen the lags between rates and refinancing. We define this as the capacity effect. It is captured by transitioning the lags from one environment to the next, when the market is "in the money" or "out of the money". The point at which we define the market to be "in the money" is when FNMA current coupon is below the mortgage market coupon. We use the JPMorgan MBS index coupon to represent the mortgage market. The level of the forward Index coupon is projected in the model.

**Daily volatility**

The highs and lows of the mortgage rate in a given month are smoothed over when using a monthly average. We try to compensate for that by incorporating the standard deviation of mortgage rates when fitting to historical data and when projecting the mortgage rate. This effect attempts to capture the fact that the mortgages are callable daily but models typically generate monthly rates. Therefore, all else being equal, a more volatile month can lead to faster speeds.

# 10. GNMA Prepayments

There are various unique characteristics of FHA/VA loans that require a separate discussion of GNMA prepayments. For example, regulatory issues/changes, the streamline refinancing program, credit, LTV, and servicer buyout activity have all influenced GNMA prepayment speeds. Taking these factors into account, we will discuss the differences between GNMA and conventional prepayment models.

**Characteristics of FHA loans**

A majority of loans in GNMA pools are covered by FHA mortgage lending programs. The FHA mortgage insurance program (MIP) is geared towards first time homebuyers who are unable to make the standard 10%-20% down payment. FHA borrowers are charged an upfront fee (currently 150bps) as well as an annual fee of 50bps. This uniform MIP pricing structure is different from the private mortgage insurance backing conventional pools with LTVs over 80%, which tend to offer "risk-based" pricing. Not only are the down payments low on the majority of FHA mortgage loans, but borrowers can also incorporate the closing costs in the mortgage. This tends to inflate the effective loan-to-value (LTV) ratio on GNMA pools to 95% or more. GNMA borrowers tend to be low to moderate income with relatively poor credit and/or insufficient funds for a down payment.

Conventional Alt-A mortgages typically have much higher FICO scores and frequently lower LTVs than FHA mortgages. The FHA mortgage is intended only for owner occupancy and generally excludes investment properties. One exception, is the 203K program, which allows for non-profit "investors". These loans frequently include a home improvement component, and tend to be at higher rates than standard FHAs. This explains why average loan balances for higher coupon GNMAs are often larger than for the production coupons, whereas for conventional loans the higher loan balances are concentrated in the production coupons. Furthermore, high coupon GNMAs are also likely to be backed by multi-family properties.

**Differences in borrower and loan characteristics between GNMA and conventionals**

| GNMAs | Conventionals |
|---|---|
| LTV (high 90s) | LTV (average low 70s) |
| Almost all FHA loans pay MIP fees. | Mortgage insurance required only if LTV >80. |
| Lower loan balances; loan limits are set at 87% of conforming loan limits in high-cost areas. (For 2001 vintages, GNMA pools have, on average, $31,000 lower loan sizes than FNMAs.) | Higher loan balances (current limit is $322,700) |
| Larger share of lower income borrowers | |
| High delinquency rates | Generally high FICOs and low delinquencies. |

**The structure of FHA insurance fees impacts GNMA prepayments.**

The two components of the FHA insurance fees may have significant implications for GNMA prepayment speeds. Up-front FHA insurance fees have been gradually reduced over the years. A mortgagor refinancing from one GNMA mortgage into another can avail of a refund on the up-front insurance premium, which could be a driver of GNMA prepayments. In addition, moderately seasoned FHA borrowers, with market LTVs lower than 80% could refinance out of GNMAs into conventionals. This refinancing will allow these borrowers a partial refund on their up-front insurance premium and also relief from the 50bps annual MIP.

**The upfront MIP has remained stable at 150 bps since January 2001 and has had little impact on speeds of loans originated post 2001.**

The upfront fee has steadily decreased from 3.8% pre-1993 to 1.5% after the last round of revisions in January 2001. If the loan is prepaid, a borrower is entitled to a refund in accordance with an amortization schedule. This refund provides an incentive for GNMA to GNMA refinancing. For example, loans originated just prior to January 2001 paid an upfront fee of 225bps. If these borrowers refinanced after 12 months, they would receive a 202bp refund on the up-front MIP. Thus, refinancing and paying a revised up-front MIP of 150bp would still put the borrower ahead by 52bps. However, the upfront MIP has remained stable at 150 bps since January 2001 and has had little impact on speeds of loans originated post 2001. Refunding of the up-front MIP would depend on the original up-front MIP paid by the mortgagor and the current amortization schedule for refunds.

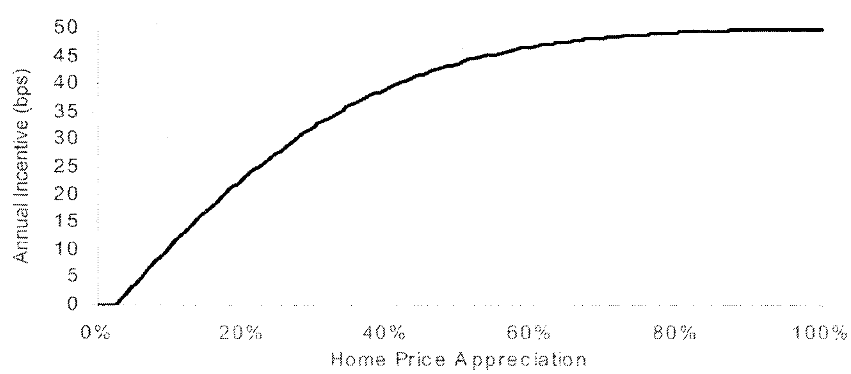
**The strong housing market has provided a boost for GNMA to conventional refinancing**

The impact of the 50bps annual fee is subtler. It effectively raises the WAC to the borrower by 50bps. If the borrower's amortized LTV declines to 78%, then this annual fee is waived. But if the market LTV declines to 80%, the borrower will have an incentive to refinance into conventionals to avoid paying the MIP. It appears that the strong housing market in the late 1990s had a huge impact on the GNMA to conventional refinancing. The GNMA sector continues to lose market share to conventionals. For example, from 2001 to March 2003, net issuance in the GNMA sector has been negative $77 billion compared to $374 billion for the FNMAs.

In the JPMorgan prepayment model, we explicitly incorporate the impact of cumulative home price appreciation on the annual incentive. An increase in home price appreciation leads to a higher incentive to refinance into a conventional mortgage. Since GNMA borrowers do not exercise this option optimally, we estimated that a 20% cumulative home price appreciation corresponds to roughly 18-20bps of higher incentive to refinance.

**Impact of HPA on GNMA to conventional refinancing**

**Exhibit 34: Impact of home price appreciation on GNMA to conventional refinancing**



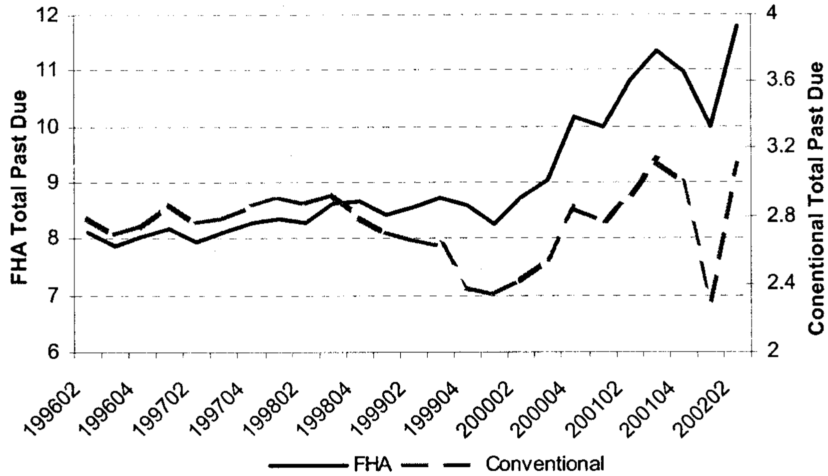

Source: JPMorgan

**Credit constrained GNMA borrowers tend to have higher delinquencies**

Given the higher LTV and lower income status of the GNMA borrower, it is not surprising to observe that delinquencies have been significantly higher for GNMA pools than for conventionals. From early 2001 and the second quarter of 2002 the total past due on FHA loans went up from 10% to 11.8%. During the same period, the total past due on conventional loans rose from 2.3% to 3.1%. Delinquencies on premium MBS could have a large impact on GNMA speeds due to servicer buyout activity. Servicers have economic incentive to buy out these premium mortgages at par, make them performing, and sell these loans in the market at a premium.

**Percentage of past-due FHA and conventional loans**

**Exhibit 35: Total past-due loans for both conforming and FHA mortgages**



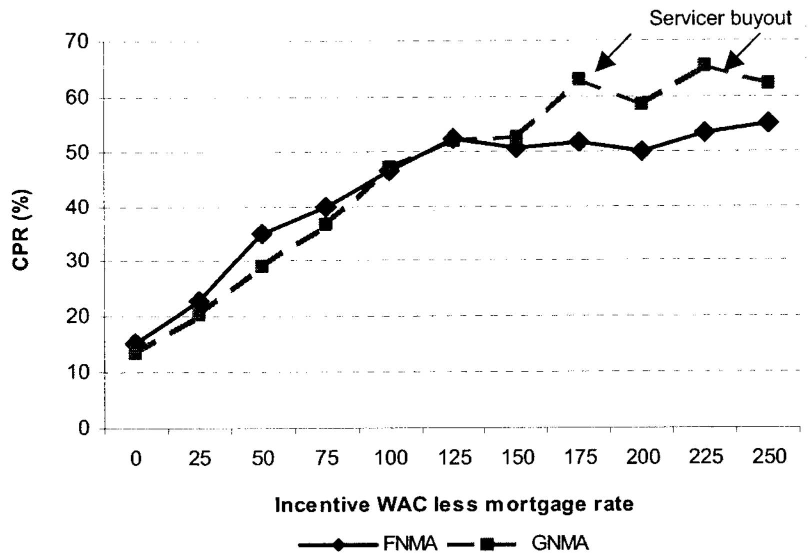

Source: MBA

**Servicer buyout activity continues to have an impact on the speeds of seasoned premiums**

Under certain circumstances, GNMA servicers are permitted to buy out loans at par from pools if the loans are 90-days delinquent. Until January 2003, 90-day delinquent loans also included loans that were 90-days rolling delinquent, with potentially only one missing payment. In Exhibit 36, we show the prepayment impact of servicer buyout on GNMA pools with 12-18 months of seasoning, as observed in January to August 2002. It seems that an acceleration of almost 10% CPR can be attributed to buyout activity. However, revised GNMA rules prohibit buyouts of rolling delinquent loans originated subsequent to January 2003. This should mitigate the impact of servicer buyout activity on newer pools.

**Servicer buyout activity could at times account for almost 10% CPR acceleration**

**Exhibit 36: Impact of servicer buy-out activity (Jan to Aug 2002, 12-18 WALA)**




Source: JPMorgan, FNMA, GNMA

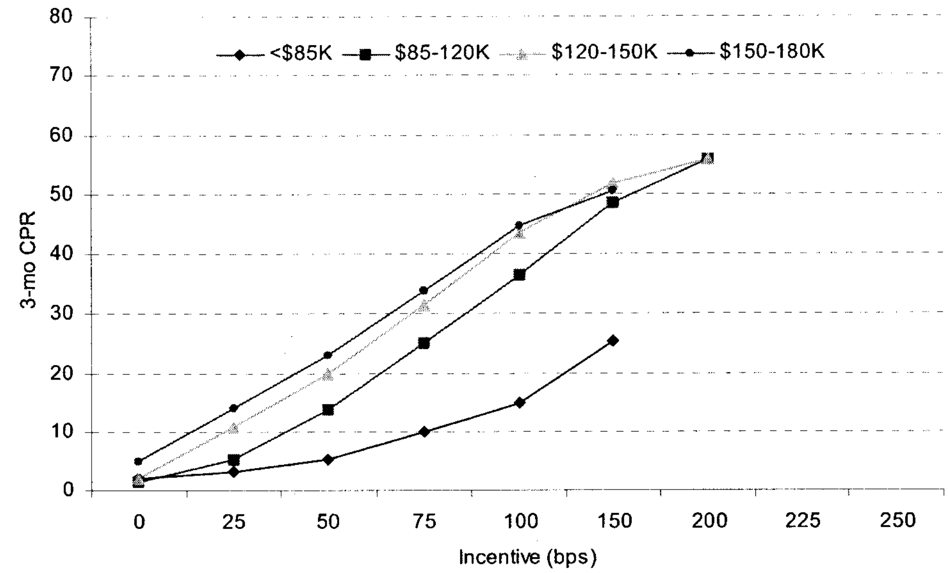
**Impact of loan size in GNMAs**

We also observe a couple of differences between GNMA and conventional prepayments. At the cusp, prepayment differential by loan size is significantly smaller on GNMAs relative to conventionals. For this analysis we define "cusp" as loans with 50bps of refinancing incentive. The corollary of this observation is that the prepayment gradient is steeper for GNMAs than conventionals. Prepayments down the curve on conventionals[8], coupled with limited incentive to refinance from GNMAs into GNMAs, have kept speeds at the cusp slower for GNMAs relative to conventionals. Another difference is that deep-in-the-money low loan balance GNMAs provide less prepayment protection when compared to conventionals.

[8] FHA Hybrid ARMs will be offered in the fall of 2003. This may lead to a short-term increase in GNMA to GNMA refinancing.

**GNMA 30-years: Prepayments by loan balance**

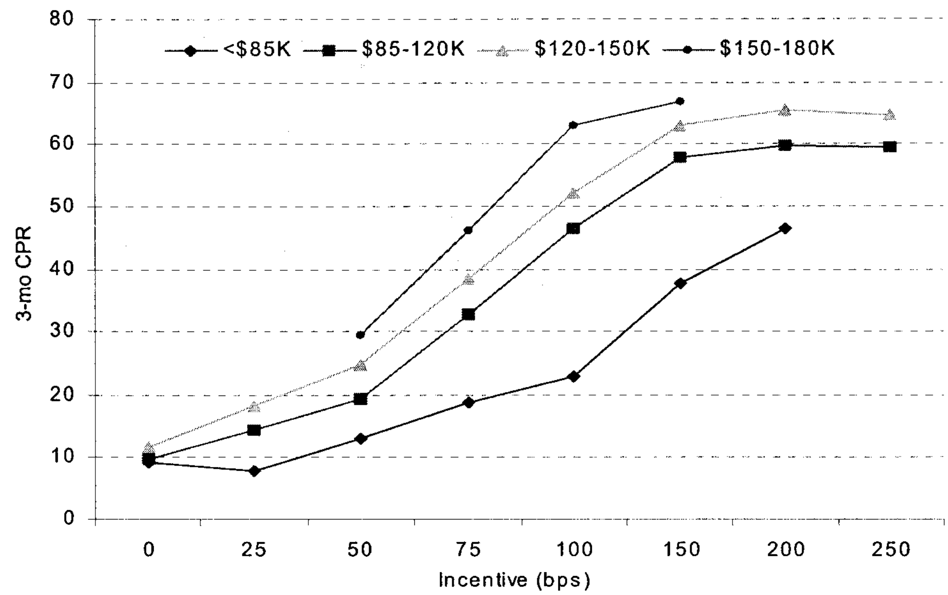
**Exhibit 37: February 2003 prepayments on 2002 GNMA 30-years**




Source: JPMorgan, GNMA

**GNMA speeds for 2001 originations are similar to conventionals, adjusted for incentive and loan balances.**

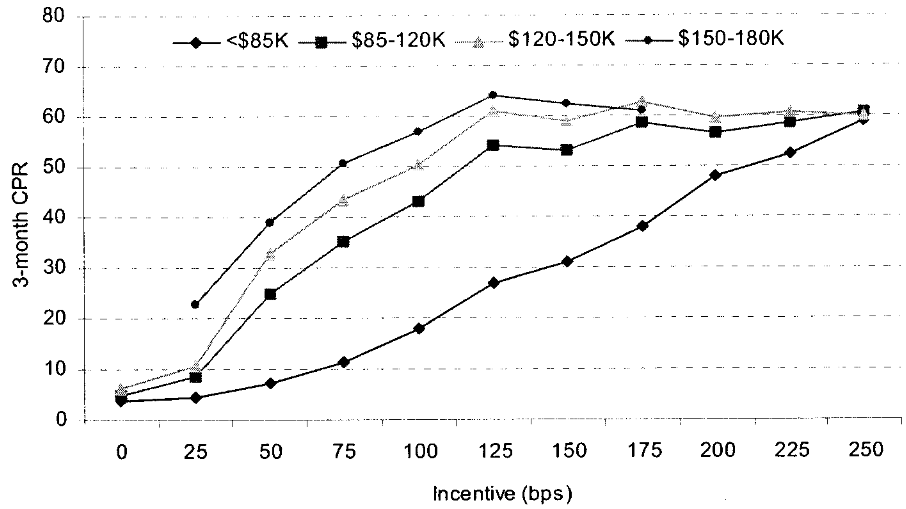
**Exhibit 38: February 2003 prepayments on 2001 GNMA 30-years**




Source: JPMorgan, GNMA

**Low loan balance GNMAs display a flatter S-curve, especially for balances below $85,000**

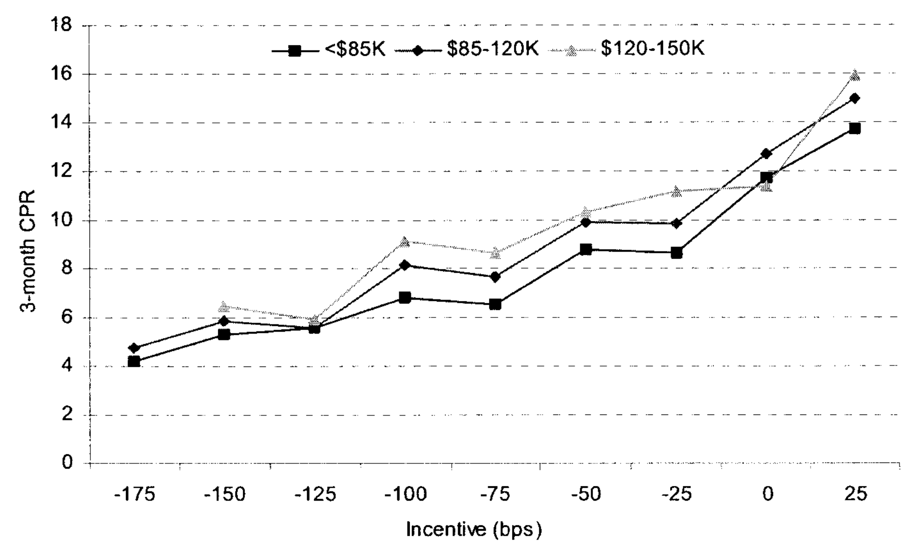
**Exhibit 39: December 2001 prepayments on 2000 GNMA 30-years**




Source: JPMorgan, GNMA

For 2000 vintage, the low loan balance GNMAs continue to provide excellent call protection. However, for large enough incentives (in this case more than 200bps) prepayments on low loan balance pools do converge with the speeds on the larger loans. This differs from low loan balance conventionals where speeds never appear to converge with the large loans even at extreme incentives. For recent production low loan balance GNMAs (such as off of 5.5% collateral), the foremost feature is the relatively flat S-curve.

**Exhibit 40: December 2000 prepayments on 1998 GNMA 30-years**




Source: JPMorgan, GNMA

**Low loan balance GNMAs did not provide incremental extension protection in 2000...**

There are at least a couple of conclusions that can be drawn from Exhibit 40. For one, low loan balance GNMAs (under $85,000 average loan balance) did not offer any incremental extension protection. This is in contrast with the results in the conventional market. On the other hand, when out-of-the-money the low loan balance GNMAs prepaid at a similar pace to the low loan balance conventionals. Perhaps, the surprise is that larger loan GNMAs prepaid far faster than similar loan balance conventionals when out of the money and, consequently, offered better extension protection.

**...what about assumability (less likely for low loan balance GNMAs)**

The difference in prepayment behavior for discounts is likely primarily explained by the impact of high LTVs on GNMAs. The sector is more levered to the housing market. Home price appreciation in GNMAs provides a strong incentive to refinance in order to eliminate mortgage insurance (as LTVs drop below 80%). Assumability was clearly not a meaningful factor in 2000 as discount GNMAs prepaid faster than conventionals. Indeed, so long as the housing market is appreciating, assumability has not appeared to play a significant role.

In particular, there are two factors that make this the case for low loan balance GNMAs. Firstly, the attractiveness of GNMAs for qualifying borrowers in part relates to the allowed high LTVs; the borrowers are therefore likely to have insufficient assets to obtain a lower LTV mortgage (which could be at a significantly lower carry cost). Hence, such borrowers are unlikely to have sufficient assets to be able to assume a GNMA mortgage that has experienced even modest home price appreciation. On the other hand, GNMAs can be assumed by non-FHA qualifying borrowers. However, the low loan balance GNMAs (with high LTVs) are less likely to be purchased by a typical conventional borrower except potentially as investment properties, in which case the assumability conditions are different. Investors assuming GNMA mortgages need to reduce the LTV to 75%, potentially making assumability less attractive.

**Structural differences between GNMA and conventional prepayment models**

Therefore, unlike the conventional model, the GNMA prepayment model does not include CATO or SATO, and only a minimal impact attributable to loan size. However, it does incorporate the impact of annual MIP on GNMA prepayments. Due to lack of direct data, servicer buyout activity is also not incorporated in the GNMA model.

**The GNMA prepayment model tends to be less callable than conventionals**

Traditionally, GNMA pools have exhibited higher extension and less callablity than conventional pools. Additionally, since the advent of streamline refinancing they have displayed shorter lags to refinancing opportunities. These effects have been incorporated in the JPMorgan prepayment model. In Exhibit 41, we show speed projections (1-year CPR) for 6.5s and 7s of 2001 vintage in different rate scenarios.

**Model projections of GNMA and FNMA 6.5s and 7s of 2001 vintage**

**Exhibit 41: Speed projections for 2001 vintages, one year CPRs**

| | Hist 1-Yr CPR | Shifts (bps) As of April 7 2003 *Mtg Rate 5.7%* -100 | -50 | -25 | 0 | 25 | 50 | 100 | 150 |
|---|---|---|---|---|---|---|---|---|---|
| FN 6.5 | 47 | 80 | 76 | 72 | 66 | 58 | 48 | 28 | 15 |
| FN 7 | 50 | 68 | 66 | 64 | 61 | 57 | 52 | 38 | 24 |
| GN 6.5 | 38 | 64 | 60 | 56 | 51 | 45 | 37 | 23 | 14 |
| GN 7 | 50 | 61 | 60 | 58 | 56 | 52 | 47 | 34 | 21 |

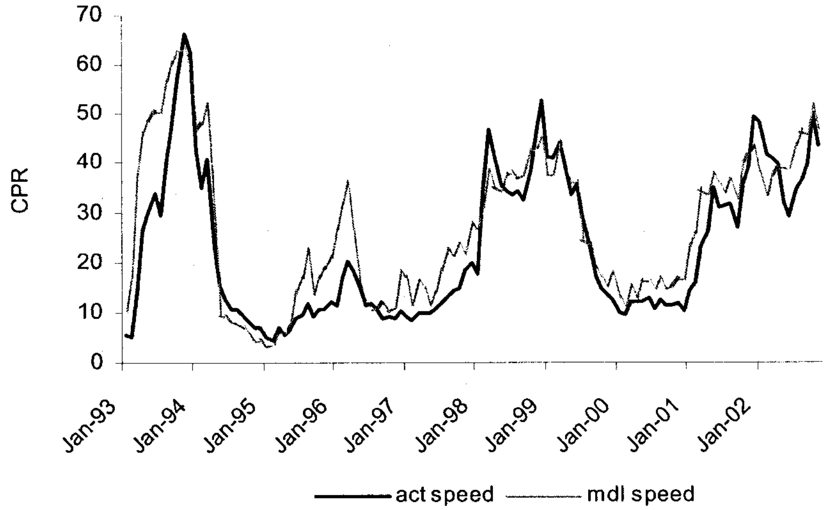
Source: JPMorgan, FNMA, GNMA

# 11. Historical Performance

As the saying goes, "Past performance is not an indication of future results". However, understanding how the model works historically, in and out of sample can help determine if the right effects are working at the right time. In the Exhibits below we display model projections along with actual historical speeds for various cohorts. We also display snapshots by WALA. The model was estimated at the WALA level rather than at the cohort level.

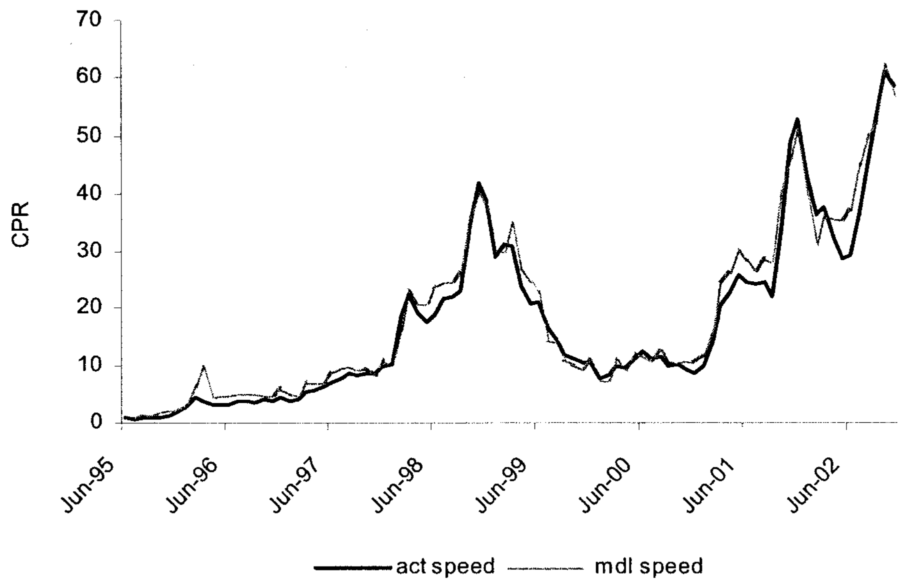
**Capturing the 1993 refinancing wave**

**(FNMA 30Y 1991 8s)**



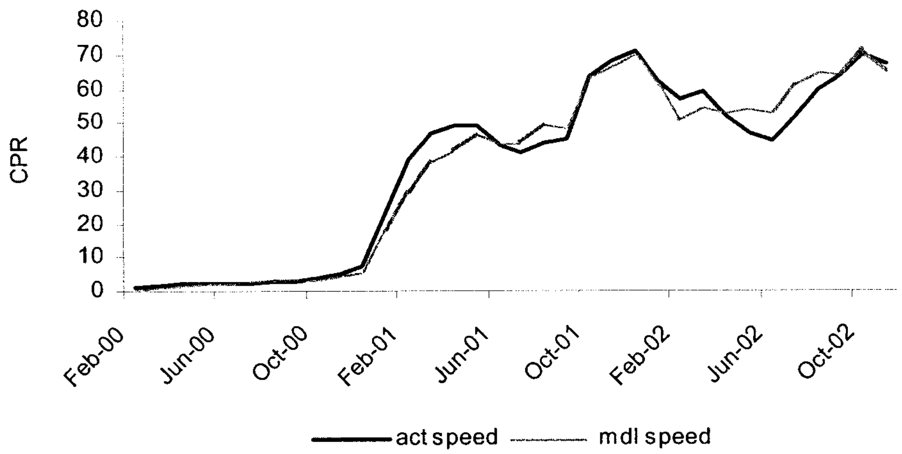

**Capturing the 1998 refinancing wave**

**(FNMA 30Y 1995 7s)**

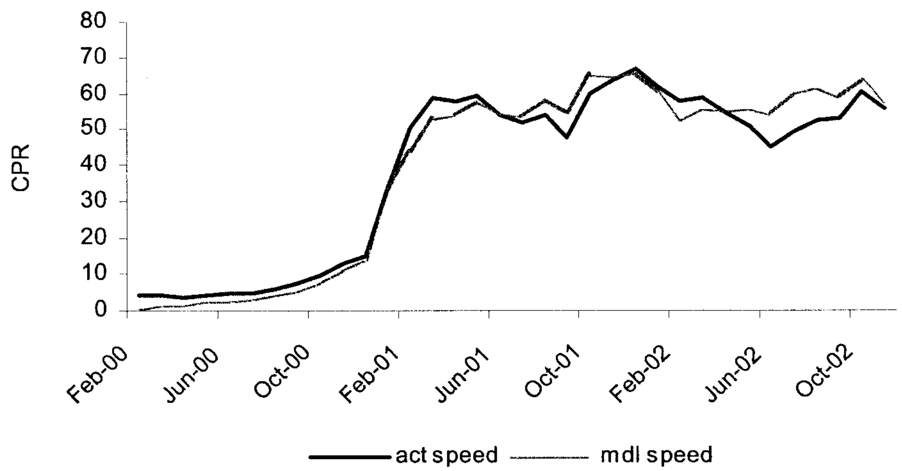


**Capturing the 2001 refinancing wave**

**FNMA 30Y 2000 7.5s prepay faster than 2000 8s**

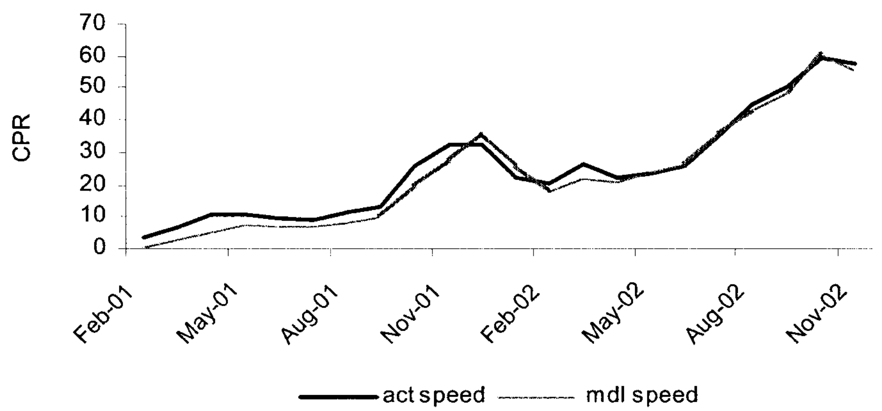



**FNMA 30Y 2000 8s**

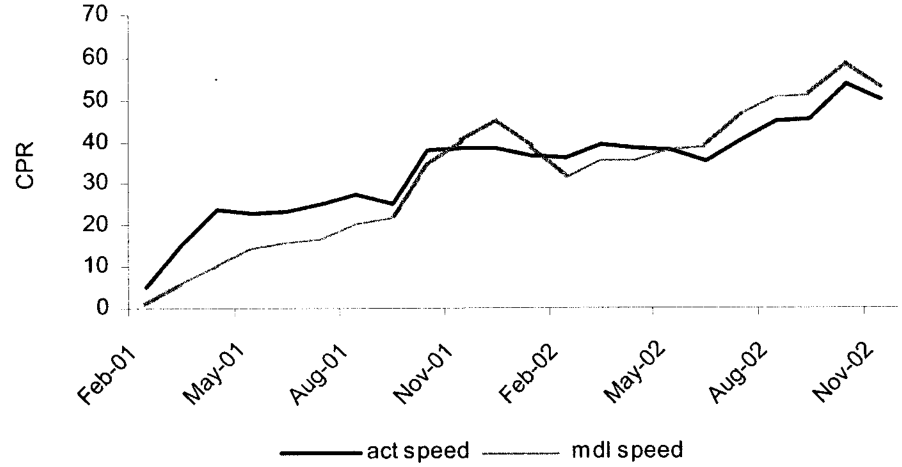



**Capturing the 2002 refinancing wave**

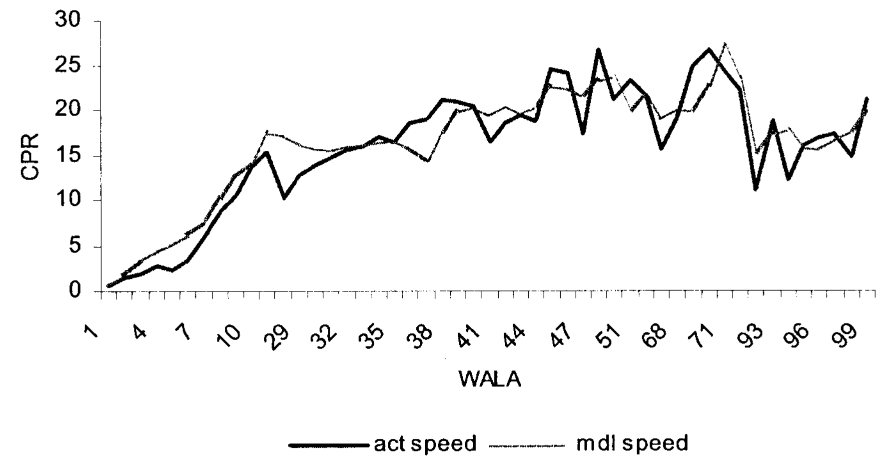
**FNMA 30Y 2001 7s**



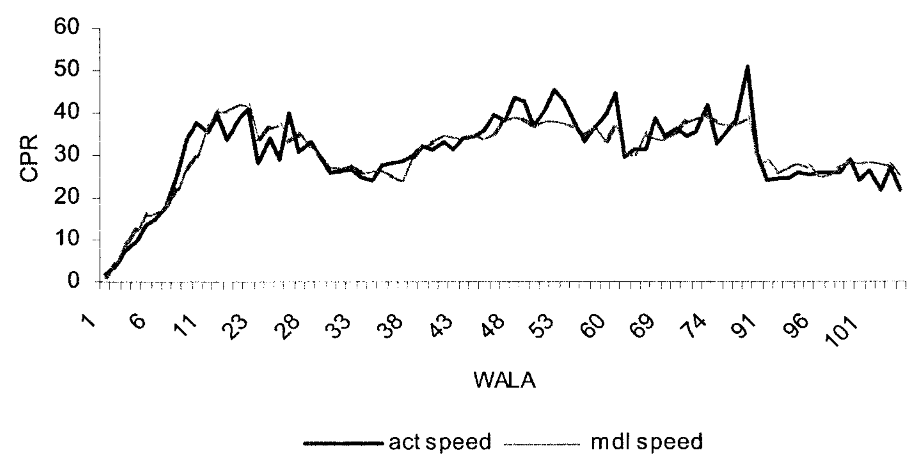
**FNMA 30Y 2001 7.5s**



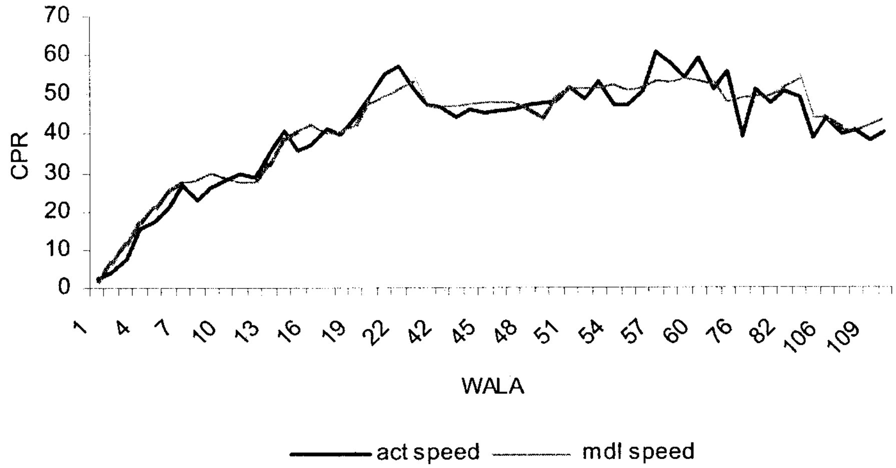

**FN 30Y 6s observed in November 2001**



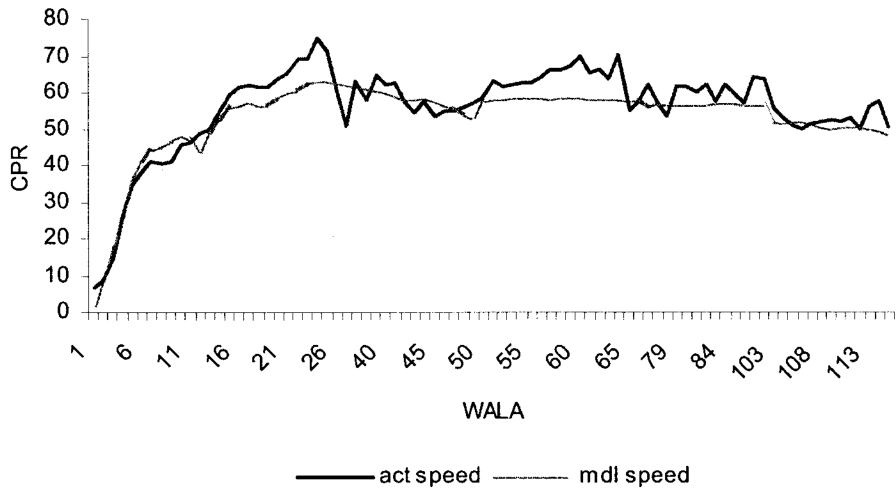

**FNMA 30Y 6.5s observed in November 2001**



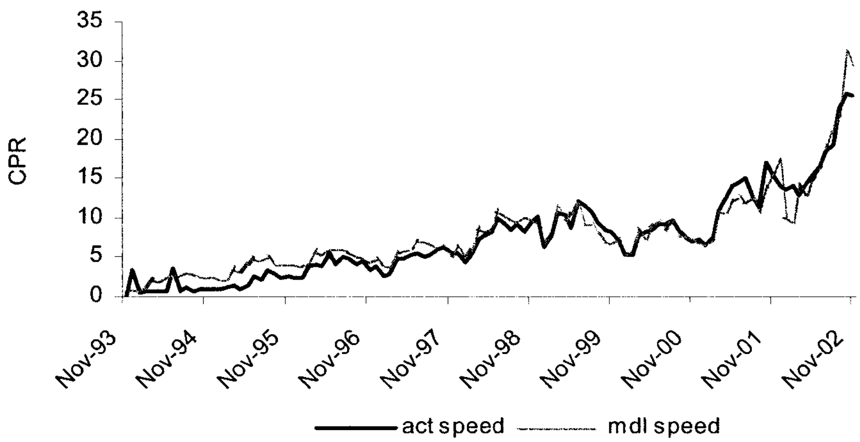
**FNMA 30Y 6s observed in November 2002**



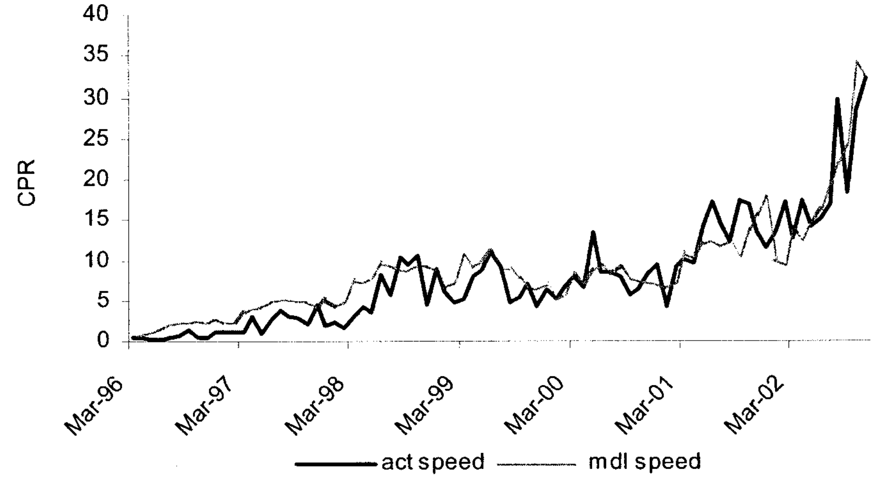

**FNMA 30Y 6.5s observed in November 2002**



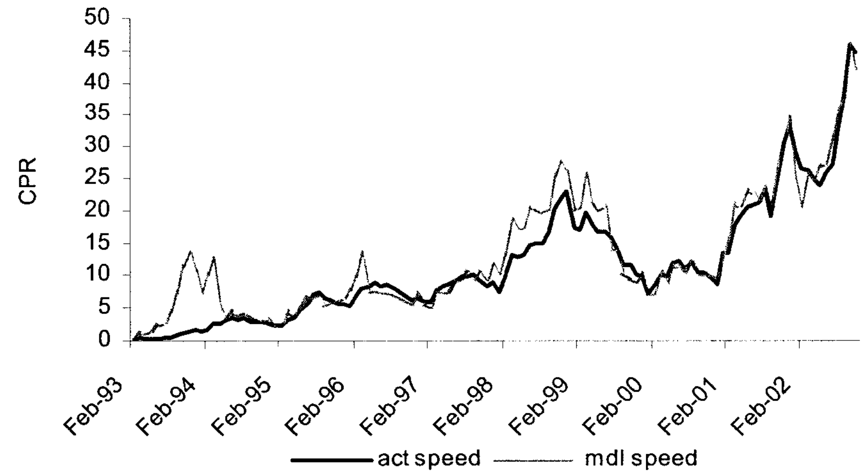

**GNMA 30Y 1993 6s**



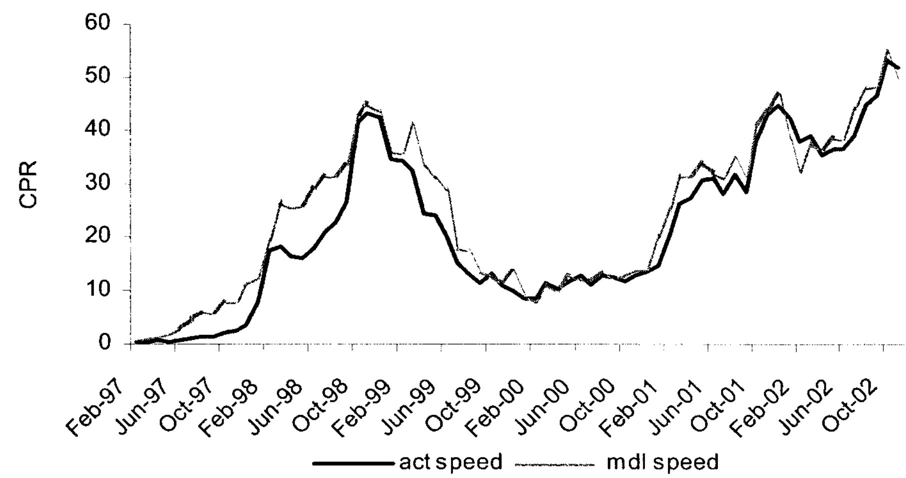
**GNMA 30Y 1996 6s**



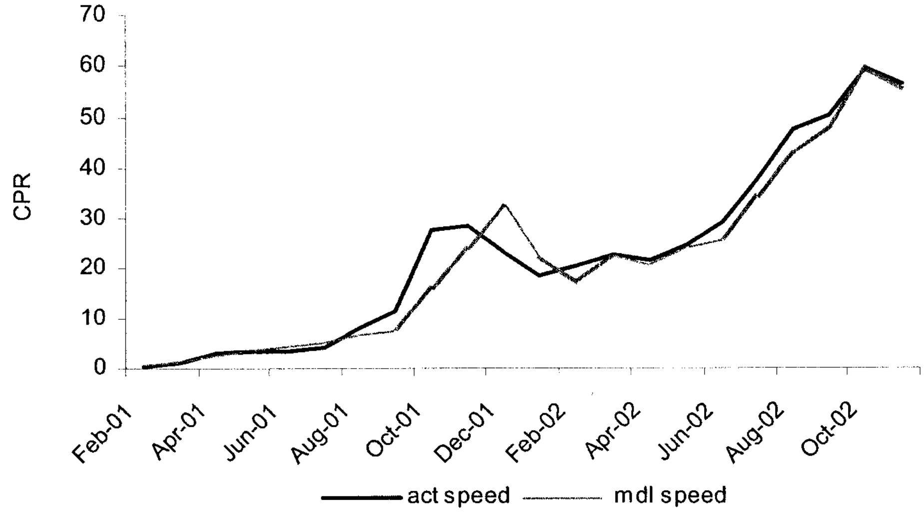

**GNMA 30Y 1993 7s**




**GNMA 30Y 1997 7.5s**



**GNMA 30Y 2001 7s**




**GNMA 30Y 2000 8s**