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What Do People Mean When They Talk About Prepayment Risk?

Although duration and convexity are useful measures of risk for mortgage securities, they do not adequately capture the effect of the *different types of prepayment risk* embedded in mortgages. Broadly speaking, *negative convexity* will reflect a mortgage's prepayment response to a change in interest rates; however, it does not capture *structural prepayment risk*, where prepayments can be substantially different from market expectations as a result of some rate-independent change in the system. This risk is separate and distinct from what is generally accepted as traditional prepayment risk or negative convexity risk. The distinction is fairly subtle, but important. We discuss this below, and highlight how these different risks are quantified and captured in a relative value framework. For example, the 6 bp OAS pickup for FNMA 8.5s makes them appear slightly cheap to 7.5s since OAS already explicitly captures the effects of negative convexity. However, the pickup may actually be insufficient to compensate for the structural prepayment risk in 8.5s. The implication is that unless investors consider both types of prepayment risk in assessing mortgage relative value, they are probably taking on more risk than expected — or being insufficiently compensated for the actual risks that they are bearing. Full consideration of the risk/reward balance confirms our view that 7.5s are the most attractive 30-year conventional coupon.

Traditional View of Prepayment Risk

Let's start with the traditional view of mortgage prepayment risk. When market participants evaluate the risk/return characteristics of mortgages, they recognize that their upside can be significantly limited in sharp rallies by rising prepayments, or negative convexity. Prepayment risk is generally thought of in the context of how prepayment rates will vary as interest rates change — i.e., faster prepayments in a rally and slower prepayments as rates back up. As a result, the concepts of prepayment risk and negative convexity risk are commonly thought of as interchangeable; and in terms of the risk/return trade-off, market participants would expect that the most negatively convex mortgages should be priced at the widest spreads. This convexity risk framework is consistent with a *ZVO curve that peaks at the coupons with the greatest negative convexity* (i.e., 30-year 8.5s or 15-year 8s) and declines thereafter as negative convexity eases for higher coupons. If convexity risk were the only risk faced by mortgage investors, this would be a reasonable expectation. But mortgage investors are also exposed to structural prepayment risk, as described below.

Structural Prepayment Risk Is Not Hedgeable With Interest Rate Instruments

In contrast with convexity risk, structural prepayment risk is the risk that future prepayments can turn out to be substantially different from past patterns, as a result of a fundamental change to some aspect of the regulatory or institutional environment. Prepayment changes caused by tax reforms, agency reforms, or underwriting reforms — all of which have been seen in the past — cannot be captured by traditional convexity measures, and clearly cannot be hedged using Treasuries, options, or any other interest rate instruments. Since this structural risk is generally unhedgeable (except to a limited extent with mortgage derivatives) and nondiversifiable (especially when most outstanding mortgages are premiums), investors deserve additional expected return (OAS) for bearing this risk.

Convexity Risk Can Be Hedged

The key distinction between traditional prepayment risk (convexity risk) and structural prepayment risk is one of hedgeability. Convexity risk can be quantified and hedged, and prepayment risk in this sense is quantified through convexity calculations. To be sure, hedging short-term price moves is not necessarily easy. Empirical durations have been volatile, and 7.5s have been much more difficult to hedge relative to 9s. This is because 9s are shorter and have exhibited less duration variability. On the other hand, we also note that 9s are much more vulnerable to a wholesale repricing and revaluation arising from prepayment risk. For example, they experienced a sharp revaluation downwards in the fall of 1993, followed by a revaluation upwards in June/July 1995.

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Quantifying Convexity Risk

As stated previously, traditional prepayment risk can be quantified and hedged on the basis of duration and convexity. Alternatively, we can also quantify this convexity risk in terms of option cost (the difference between ZVO and OAS), which is the value of the series of calls that have been shorted by the mortgage investor to the underlying mortgagors. As we can see in the table below, FNMA 8.5s have the greatest negative convexity and (not coincidentally) the highest option cost, as well as the widest static spreads and ZVOs. This type of prepayment risk is, in principle, hedgeable: The investor can "spend" the option cost to buy back convexity through the options market and capture the mortgage's OAS on a hedged return basis. (For example, in a *Market Focus* article in our October 20th issue, we illustrate how to capture the cheapness of GNMA 7.5s by buying out-of-the-money Treasury puts and calls.) Therefore, if convexity were the only risk, the OAS pickup for FNMA 8.5s would imply that they are cheaper than FNMA 7.5s, net of hedging costs. However, when we consider the impact of structural prepayment risk, we reach the opposite conclusion, favoring 7.5s over 8.5s, as illustrated below.

Negative Convexity and Option Cost of 30-Year Pass-Throughs

FNMA Coupon	Static Spread	Option ZVO	Option Cost	Option OAS	Gain Conv
6.5	90	88	**31**	57	**-0.21**
7.5	127	126	**51**	75	**-0.59**
8.5	150	157	**76**	81	**-0.77**
9.5	105	125	**67**	58	**-0.41**

Quantifying Structural Prepayment Risk

The major dimensions of structural prepayment risk are quantified by the *prepayment sensitivity* measures from the Goldman Sachs prepayment model: relo, cusp, and refi. For any given mortgage security, these sensitivities quantify the dollar price impact of an unforeseen, and therefore unhedgeable, systematic change in prepayment behavior. In other words, there exists a risk that, even with absolutely constant price durations, a Treasury-hedged premium position would still lose value and underperform if its yield and carry collapsed from unexpectedly fast prepayments for a given market level. At current market levels, the predominant prepayment risks are cusp and refinancing risk, and as the second table shows, FNMA 8.5s have substantially greater exposure to both of these risks than do 7.5s. More specifically, we are concerned that the increased efficiency of the refinancing process arising from future technological and procedural improvements (or simply a large enough increase in refinancing volume) will lower refinancing costs and cause a structural increase in prepayments.

The Effects of Structural Prepayment Risk on OAS Valuation

FNMA Coupon	Prepay Sensitivity Relo	Cusp	Refi	OAS	Price Impact of 50 bp Cusp Shift	OAS Value 1/32nd	OAS Impact of 50 bp Cusp Shift	"Risk-Adjusted" OAS
6.5	0.21	**-0.18**	-0.05	**57**	12/32	0.56	**7**	**50**
7.5	0.08	**-0.31**	-0.12	**75**	20/32	0.62	**12**	**63**
8.5	-0.01	**-0.41**	-0.24	**81**	27/32	0.86	**23**	**58**
9.5	-0.08	**-0.48**	-0.41	**58**	33/32	1.14	**37**	**21**

7.5% Coupons Are Most Attractive

To determine the impact of such an efficiency improvement, we use the displayed cusp sensitivities, which measure the percentage price declines of mortgages corresponding to an assumption that the refinancing process becomes 25 bp more efficient. Future improvements in refinancing efficiency could have the prepayment impact of a 50 bp cusp shift, in which case the value of FNMA 8.5s would decline by 27/32nds while 7.5s would fall by only 20/32nds. Adjusting for this risk at today's pricing levels, the OAS of 8.5s would decrease by 23 bp while that of 7.5s would decrease by only 12 bp. This type of risk hurts 8.5s more than 7.5s, and 9.5s most of all. So despite appearing slightly less attractive than 8.5s on a pure OAS basis, 7.5s are in fact 5 bp cheaper than 8.5s if this additional risk factor is considered. The results of this analysis across selected coupons are displayed on the right side of the table, and show the attractiveness of 7.5s relative to other conventional coupons on this "risk-adjusted" basis. (Note that discounts would *not* escape a wholesale repricing of mortgage refinancing efficiency; cusp risk significantly hurts the value of even 6.5s. Only PO-like securities would benefit.)

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In summary, structural prepayment risk is separate and distinct from traditional convexity risk; it is not hedgeable in the Treasury or options market, and investors should demand additional OAS as compensation for bearing this incremental risk today. Investors need to consider both hedgeable and unhedgeable risks carefully in arriving at their relative value decisions. And in a market where an increase in refinancing efficiency over the next 1-2 years threatens to become the next structural shock to mortgage valuations, the market should demand increasingly wider OASs for those securities with the greatest exposure to cusp risk. In other words, *the OAS curve should peak for premium securities with substantial structural prepayment risk*. Since current pricing does not sufficiently reflect this risk, we would conclude that premium coupons are significantly overvalued. Over the next few months, growing investor appreciation for structural prepayment risk — along with a plain old-fashioned pickup in short-term prepayments — should start to wear down the recent technical strength of high premium TBA pass-throughs.