Mortgage Securities

July 25, 1997 Kyle Nagel 212-902-1730

Mortgage Risk Measures: What They Mean and How to Use Them

This week, we replace three of our regular data exhibits with new formats (pages A-6, A-7, and A-13). The revised formats contain much of the same information as before, although we have slightly altered our definitions for prepayment and volatility sensitivities to make them easier to use. Here we review how we currently calculate six measures of mortgage risk: option cost, volatility sensitivity, and gain from convexity, as well as our three prepayment sensitivities — relo, cusp, and refi. Moreover, we review how the various risk measures are used and how they provide insights into the risks inherent in a given mortgage-backed security.

In the table at the bottom of this page, we illustrate the various risk measures for FNMA 7.5s as they appear on page A-6. We also present two measures of expected return: ***ZVO*** and ***OAS***. Remember that ZVO is the projected spread over off-the-run Treasuries under the assumption that interest rates move to the forward curve. In contrast, OAS allows for volatility in interest rates around the forward scenario, and is an expected return measure that incorporates the variability of prepayments as interest rates move.

Risks Related to Interest Rates

Option Cost is the difference between ZVO and OAS, which equals 67 bp for FNMA 7.5s. In the graph on the next page, we show the effect of changing volatility assumptions on the OAS of FNMA 7.5s. At a zero volatility assumption, OAS is simply equal to ZVO, and there is no option cost. However, increasing the volatility assumption lowers OAS, since purchasing a mortgage-backed security is equivalent to purchasing a noncallable bond and selling an embedded prepayment option whose value is linked to interest rate volatility. The dashed vertical line labeled "Option Cost" illustrates the magnitude of the option cost for FNMA 7.5s.

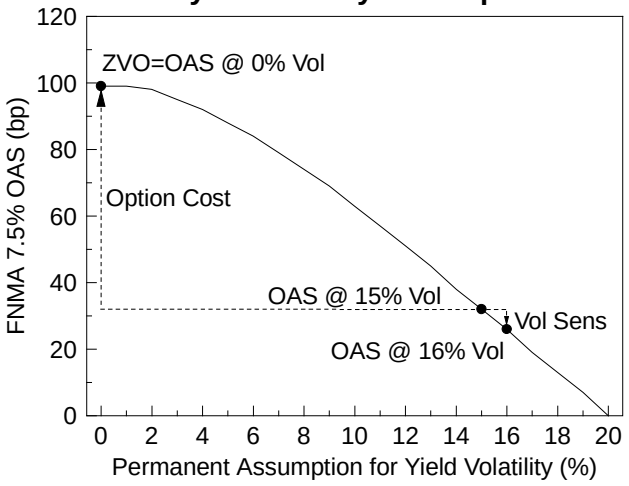
Option cost is probably the best single measure of the adverse cash flow behavior of a mortgage security. For highly stable cash flows (e.g., short PACs backed by discounts), the option cost is near zero; for highly variable cash flows (e.g., IOs and inverse IOs), the option cost can be several hundred basis points. Option cost is essentially the value of the interest rate option that is sold when a mortgage is purchased, and can be viewed as the annual cost that would be incurred if the short options position were covered with, say, a long Treasury options position. (See "Volatility and the Mortgage Market: A Primer" in the July 3, 1997, issue of *Mortgage Market Comment* for a further discussion of volatility and fixed income options).

Risk Characteristics of FNMA 7.5s

	(ZVO) Zero Vol		Option		15% Vol	Gain From	OAS Sensitivities (bp)			
Security	OAS	=	Cost	+	OAS	Conv	+1% Vol	+10% Relo	+25% Cusp	+10 Refi
FNMA 7.5	99	=	67	+	32	-0.58	-6	1	-5	-4

Pricing as of 7/24/97

OAS Sensitivity to Volatility Assumption



Volatility Sensitivity is the change in OAS for a one percentage point change in the yield volatility assumption. For example, volatility sensitivity is indicated in the graph above by the difference between the OAS at a 15% volatility assumption and the OAS at a 16% volatility assumption (the vertical line labeled "Vol Sens"). For FNMA 7.5s, volatility sensitivity currently equals –6 bp, indicating that a one percentage point permanent increase in yield volatility (to 16% from 15%) would lower OAS to 26 bp from 32 bp. Conversely, a one percentage point decrease in the volatility assumption (to 14%) would increase OAS to 38 bp from 32 bp; a further decline to 13% volatility would raise OAS to 44 bp. Volatility sensitivity is essentially the "vega" of the embedded option: Vega measures an option's price sensitivity to volatility, which we now convert into basis points for mortgage securities.

Gain From Convexity is an estimate of the percentage change in price that is not explained by duration, given a 100 bp parallel shift in the yield curve. Most mortgage-backed securities exhibit negative convexity, which derives primarily from the embedded short prepayment option position, causing mortgage prices to rise less in a rally than they fall in a sell-off. "Convexity" is analogous to the "gamma" of an option; the "gain from convexity" over a 100 bp rate move is numerically one-half of convexity itself.

One limitation of convexity measures is that mortgage valuations can behave quite differently at different yield levels. For example, the convexity that best explains price movements for 25 bp rate shifts can be quite different than the convexity that best explains price movements for 100 bp rate shifts. In contrast, option cost is computed using the entire probability-weighted distribution of possible interest rate paths, and therefore gives a risk measure that is more complete than any single convexity measure.

Another limitation of convexity as a measure of mortgage risk is that even *static* cash flows contribute to price convexity. Static cash flows always have positive convexity, which can be large relative to the negative convexity that derives from the cash flow variability of a mortgage. As a result, the convexity of a mortgage security understates its true risk, as the positive convexity of the static cash flows offsets all or part of the negative convexity of the variable cash flows. This effect is most pronounced for long cash flows. Option cost does not suffer from this shortcoming, and is a better measure of the inherent optionality of a mortgage security. For these reasons, we now show option cost instead of gain from convexity on our standard valuation tables.

Risks Unrelated to Interest Rates

Closely related to convexity are the three structural prepayment sensitivities: relocation (relo), cusp, and refinancing (refi). The risk of future structural changes in prepayment behavior from regulatory or technological innovations *cannot* be hedged using Treasury instruments, and often cannot be hedged for the mortgage market as a whole. For example, a premium-dominated mortgage market cannot escape the risk of structurally faster refinancing behavior in the future. The OAS of a mortgage security can be thought of as the excess return after the interest rate risk is hedged out. This excess return compensates the investor for the structural prepayment risk that cannot be hedged out. Thus, a mortgage derivative with 10 times the leveraged prepayment exposure of a pass-through may well deserve 10 times the OAS to be fairly priced. Alternatively, investors whose prepayment or volatility assumptions differ from ours can use their own combination of these sensitivities to formulate OASs and relative value views that correspond more closely to their own assumptions.

Relo Sensitivity is the change in OAS for a 10% increase in the baseline relocation component of our prepayment model. FNMA 7.5s currently have a relo sensitivity of 1 bp, indicating that a permanent 10% increase in relocations would increase OAS by 1 bp. A shift in relocation rates might result, for example, from a major change in the economics or the taxation of housing transactions. In general, relo sensitivity is positive for discounts and negative for premiums; faster turnover usually helps discounts and hurts premiums.

Cusp Sensitivity is the change in OAS corresponding to a 25 bp increase in future prepayment incentives. This amounts to increasing the refinanceability of a mortgage, and for FNMA 7.5s would change OAS by –5 bp. Thus, if mortgages were to become 25 bp more refinanceable than our model expects, the OAS of FNMA 7.5s would decline to 27 bp from 32 bp. Cusp sensitivity is almost always negative for all pass-throughs, and tends to be most extreme for 150–200 bp premiums.

Refi Sensitivity measures the change in OAS given a proportional 10% increase in the future pace of monthly refinancings. This could happen, for example, if the qualifying rules for refinancing were to become more lenient. For FNMA 7.5s, the –4 bp refi sensitivity indicates that OAS would decline to 28 bp from 32 bp if refinancings structurally increased by 10%. Refi sensitivity is negative for all pass-through coupons, and most negative for the highest priced, fastest-paying coupons.

Implications for Relative Value

The table below shows the various risk measures for a number of pass-throughs, as well as for an IO and a PO (both strips are backed by 7.5s). As indicated in the table, FNMA 8.5s have the most negative convexity, volatility sensitivity, and option cost, whereas 9.5s are the most sensitive to the three major prepayment risks. Negative convexity, option cost, and volatility sensitivity reflect prepayment response to changes in interest rates. However, they fail to capture structural prepayment risk, whereby prepayments can be significantly different from market expectations as a result of some rate-independent force. Since this structural risk is essentially unhedgeable and nondiversifiable, investors demand (and deserve) a higher expected return (OAS) for bearing this risk.

This result is borne out empirically, as FNMA 9.5s offer a higher OAS than 8.5s, the most negatively convex, optional (as evidenced by option cost), and volatility sensitive pass-through listed in the table. The key distinction is that 9.5s are more susceptible to structural prepayment risk than are 8.5s, and this risk is difficult — if not impossible — to hedge, and investors *should* be compensated for this unhedgeable risk.

As is apparent in the table, anything that is detrimental to a pass-through's return is an order of magnitude worse for an IO. For instance, Trust 272 IO (backed by 7.5s) has an option cost of 517 bp versus 67 bp for FNMA 7.5s. This is not a surprising result, given the IO's leverage. In fact, by any measure, Trust 272 IO has more than five times the risk of FNMA 7.5s. With an OAS only three times that of collateral, the extra risk may not be fairly compensated in the market. A pass-through funded with five-to-one leverage would have higher OAS and lower risk than the IO.

On the other hand, POs have a negative option cost, indicating that the optionality of the underlying

Risk Characteristics of Selected Mortgage-Backed Securities

	(ZVO)					Gain	OAS Sensitivities (bp)			
	Zero Vol		Option		15% Vol	From	+1%	+10%	+25%	+10%
Security	OAS	=	Cost	+	OAS	Conv	Vol	Relo	Cusp	Refi
FNMA 6.5	69	=	39	+	30	-0.28	-5	4	-2	-2
FNMA 7.5	99	=	67	+	32	-0.58	-6	1	-5	-4
FNMA 8.5	123	=	83	+	40	-0.70	-7	-1	-10	-8
FNMA 9.5	112	=	71	+	41	-0.48	-6	-5	-13	-11
T272 IO (7.5)	608	=	517	+	91	-5.70	-29	-79	-161	-52
T272 PO (7.5)	-126	=	-109	+	-17	1.51	4	37	62	18

Pricing as of 7/24/97

collateral is beneficial. The other risk measures provide similar conclusions. Again, this result is not surprising, given that the return on a PO generally increases when prepayments rise. For this reason, POs are often used to add convexity to a portfolio, and to offset the prepayment risk of other mortgage holdings. This comes at the cost of a slightly negative OAS; in today's market, mortgage investors cannot easily reduce their exposure to the dominant prepayment risks (cusp and refi) without reducing return.

All of our mortgage risk measures provide some insight into the risks inherent in a mortgage security. Which risk measure is most important depends on the market environment and the investor's time horizon, hedging strategy, and overall portfolio structure. For efficient portfolios, investors should hedge the undesirable risks that *can* be hedged, and make sure they are being compensated for any important risks that *cannot* be hedged.