

Wrestling With Mortgage Durations

Recent volatility in the markets, combined with swings in MBS OASs, have again illustrated the difficulty of predicting MBS price moves. Given the current environment, we review some of the key assumptions and issues relating to mortgage durations.⁴ We also discuss directionality in mortgages, when it occurs, and its implications for hedging.

Effective Durations: Don't Blame the Messenger. Mortgage traders and portfolio managers must contend with the fact that neither model or market based durations will provide good hedges all the time. The most commonly used model measure, effective duration, estimates price moves due to a single factor, namely parallel yield curve moves. In reality, MBS prices are affected by multiple factors, such as various parts of the yield curve, volatilities, OAS changes, and so on. Since effective duration does not attempt to capture the impact of these multiple factors, it should not be expected to predict price changes due to these factors. If we restrict attention to what are typically the most important risk factors, then the difference between actual and projected price moves (using effective durations) is given by⁵

$$\text{Actual \% Price Change} - \text{Proj \% Price Change} = \text{SUM} [\text{Change in Risk Factor } k * \text{Duration of MBS with respect to Risk Factor } k]$$

$$\cong -D_s \Delta s - D_v \Delta v - D_c \Delta c + \frac{1}{2} C_y \Delta y^2 - \sum D_{y_j} (\Delta y_j - \Delta y)$$

where D_k and C_k represent duration and convexity to risk factor k , respectively, and $s = \text{OAS}$, $v = \text{volatility}$, $c = \text{current-coupon spread}$, $y = \text{chosen Treasury yield (typically the ten-year)}$ and $y_j = \text{key yield-curve rates}$.

Since one or more risk factors will typically change in any period, it follows that actual and projected price changes will differ in most periods. We can hedge against most of these risk factors, such as using several Treasuries (via partial durations) to hedge against nonparallel yield curve shifts. However, since changes in OAS can be thought of as reflecting changes in factors not explicitly in the model, it is difficult to completely hedge against changes in OAS. Hence, the effectiveness of model-based hedging ultimately depends on how stable OASs are, and whether any changes can be predicted. We return to this topic later.

⁴ Many of these issues have been discussed in detail in the paper *Effective and Empirical Durations of Mortgage Securities*, September 1996, and in *Bond Market Roundup: Strategy*, October 4, 1996 and November 1, 1996.

⁵ See Appendix A of *Effective and Empirical Durations of Mortgage Securities* for a mathematical derivation. For illustrative simplicity, we assume a single volatility.

Do Empirical Durations Help? Market-based durations reflect actual recent price moves, and hence can incorporate the influence on MBS prices of changes in the risk factors described above⁶. However, there are several caveats:

- For empirical durations to be accurate predictors of MBS price moves, relationships displayed in past data have to persist going forward (i.e., the future has to resemble the past). For example, if there has been directionality between OAS and yield changes, this should persist at similar levels going forward.
- If empirical durations have been calculated using daily data (as they usually are), they may not work well for longer hedging periods. For example, directionality between OAS and yield changes in daily changes may not be present in weekly or monthly changes.
- There are various statistical issues in the estimation of empirical durations, such as the choice of which Treasury to use, instability in empirical partial duration estimates due to high correlations between different Treasuries, bias due to durations changing as rates change, and so on. Care is required when using empirical durations.

Historical studies⁷ suggest that, *on average*, empirical durations have underperformed effective durations from Salomon Brothers' models in terms of hedging effectiveness.

Directionality and Mortgage Durations. Over the last month, effective durations have been consistently longer than empirical durations⁸. **While this does not by itself mean that effective durations will underperform empiricals in hedging effectiveness,**⁹ it does indicate a significant degree of directionality in daily MBS price changes. Two risk factors that have exhibited significant directionality recently with yield changes are OASs and volatilities. It can be shown¹⁰ that, ignoring certain non-relevant terms, the relationship between empirical and effective durations is given by

$$\text{Empirical} = \text{Effective} + \text{Correlation between Vol and Yield Chgs} * \text{Multiplier} \\ + \text{Correlation between OAS and Yield Chgs} * \text{Another Multiplier}$$

It follows that if volatilities and OASs increase as Treasury yields decline, then the correlations will be negative, and hence effective durations will be shorter than empiricals. There is some evidence that volatilities over the last couple of years have been *normal* rather than *lognormal* (as assumed by our term structure model); in other words, absolute rather than percentage yield changes have displayed constant volatilities. If this is indeed true, then using a lognormal assumption (that percentage volatilities remain unchanged as rates change) will lead to understating volatilities as rates decline; since absolute volatilities are constant, then percentage volatilities are actually increasing as rates fall. While this does lead to effective durations being overstated, and leads to questions about the volatility assumptions used in term structure models,¹¹ it is possible to hedge volatility exposure, and we, therefore, will focus on OAS directionality.

As discussed in the previous publications cited in footnote 4, historical studies have shown little persistent directionality between Salomon Brothers' OASs and yield changes. Figure 3, which shows daily OAS changes for conventional 8s versus daily changes in the ten-year Treasury

⁶ Empirical durations are discussed in detail in detail in the paper cited in footnote 1.

⁷ See *Effective and Empirical Durations of Mortgage Securities*.

⁸ Manifold MB728 (also part of the MBS Key Issue Package (MB725)) shows empirical durations obtained by regressing daily percentage MBS price changes against changes in the 10-year Treasury yield.

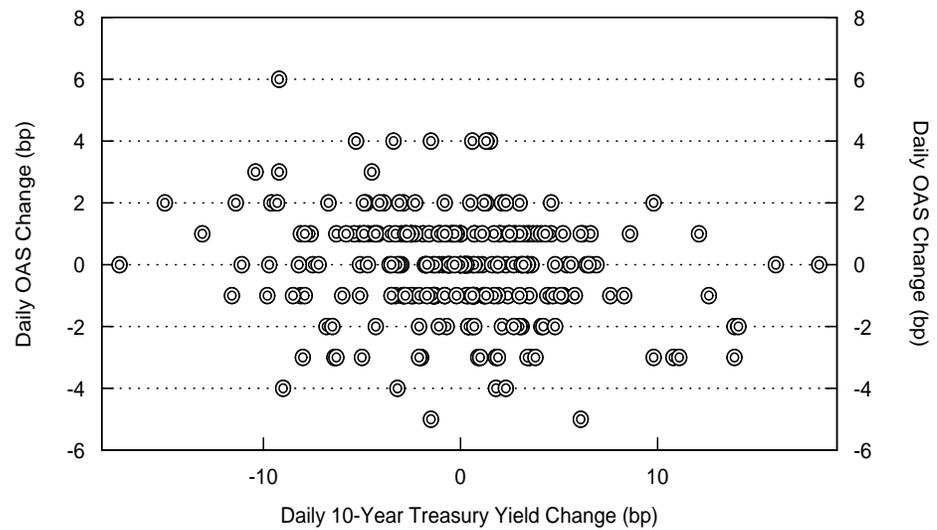
⁹ See *Effective and Empirical Durations*.

¹⁰ See page 5 of *Effective and Empirical Durations*.

¹¹ We are grateful to Biv Wadden of Stein Roe for many insightful comments on this issue.

yield, indicates that there has been little directionality on average over the last year.¹²

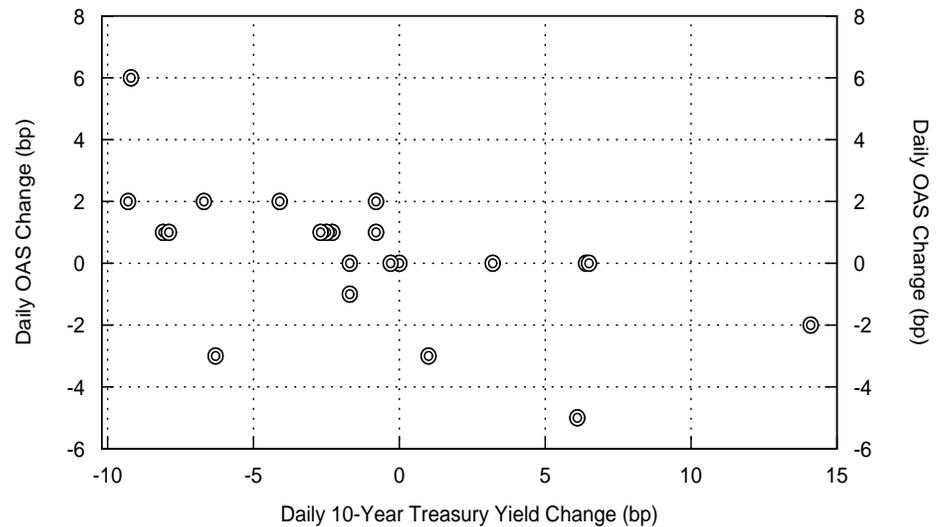
Figure 3. OAS Changes for Conventional 8s and Ten-Year Treasury Yield Changes, 30 Oct 96-30 Oct 97



Salomon Brothers Inc.

However, recent data shows pronounced directionality, as is clear from Figure 4.

Figure 4. OAS Changes for Conventional 8s and 10-year Treasury Yield Changes, 30 Sep 97-30 Oct 97



Salomon Brothers Inc.

Why have recent data shown directionality? One explanation is that rates have declined sharply since early September, on top of a significant rally from April through August, and the latest declines seem to have reawakened prepayment fears. There was also fairly significant directionality in early 1996, again due to prepayment fears. Hence, while OASs from our model are typically not directional, they may be directional when there are widespread refinancing fears. In fact, there is some evidence that, while there seems to be no persistent relationship between OASs and Treasury yield levels, there may be a relationship between OASs and some measure of refinancing fears (such as the *Media Effect* used in

¹² We use fixed-vol OASs as these do not adjust for volatility changes after the fact.

Salomon Brothers' prepayment model).¹³ In other words, while it seems difficult to predict OASs in terms of yield levels, it may be possible to predict them in terms of a variable that depends on the level of yields now relative to the past.¹⁴

If this thesis is correct, it follows that *a sharp drop in interest rates that leads to widespread refinancing fears may lead to a temporary widening in OASs; however, as rates stabilize, OASs will revert back to previous levels. This behavioral pattern is consistent with little OAS directionality over the long run, but some directionality when we are in a period of widespread refinancing fears.*

What does this imply for hedging? It implies that if the Media Effect (or whatever similar measure seems to best capture OAS movements) is high, then predicted OASs should be incorporated into the calculation of hedge ratios. This is especially relevant if the hedging horizon is very short, such as a few days. For long horizons, OASs may be expected to revert back (assuming interest rates stabilize), and there may be less need to predict OASs.