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The Multiple Dimensions of Mortgage Durations

The recent bond market rally, and the consequent shortening in MBS durations, once again illustrates the difficulty in managing the durations of mortgage portfolios. Investors and portfolio managers can use either model-based (or effective) durations or those based on market data (empirical durations), or some combination of the two. However, as discussed in a recently published Salomon Brothers research paper,[7] both effective and empirical durations incorporate various assumptions, and it is important to be aware of the properties and possible biases of the duration measures being used.

Effective Durations and Multiple Risk Factors

An MBS's price movement is a function of multiple risk factors, while effective duration measures the effect of just parallel yield-curve shifts. A new Salomon Brothers duration report, partially reproduced in Figure 5,[8] contains a section providing partial durations from Salomon's model with respect to changes in the following factors:

Non-Parallel Yield Curve Shifts. The impact of yield curve reshaping is indicated by partial durations with respect to the 2-year, 5-year, 10-year, and 30-year Treasuries.

Volatility Duration gives the percentage change in price for an absolute 1% parallel shift in the term structure of implied volatilities.

Spread Duration gives the percentage change in price for a 100bp change in OAS (this is similar, in concept, to modified duration).

Current-Coupon Duration gives the percentage change in price for a 100bp change in the current-coupon spread (i.e., in the 30-year mortgage rate).

Prepayment Duration gives the percentage change in price for a 10% change in prepayment rates.

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[7] *Effective and Empirical Durations of Mortgage Securities*, Lakhbir Hayre & Hubert Chang, September 1996. See also *Bond Market Roundup : Strategy*, Salomon Brothers Inc, October 4, 1996.

[8] The full report, which covers pass-throughs, IOs and ARMs, is available through the *Yield Book* (manifold MB728) and is also included in Salomon's MBS Key Issue Package.

Figure 5. Partial Durations for Pass-Throughs

	WAM	Price	OAS	Eff Dur	Eff Conv.	Partial Durations 2-Year	5-Year	10-Year	30-Year	Volatility	Spread	Current Coupon	Prepayment
GNMA													
30-Year													
7.0	29-04	98-04	44bp	5.5	-1.1	0.3	1.4	2.8	1.0	0.3	5.4	-0.8	0.0
8.0	29-10	102-10	50	4.1	-1.5	0.4	1.6	1.5	0.6	0.3	4.6	-1.4	0.2
9.0	27-11	105-26	48	2.2	-1.8	0.5	1.3	0.2	0.3	0.3	3.5	-2.0	0.5
10.0	20-09	109-24	79	2.4	-1.1	0.5	1.6	0.4	0.0	0.2	3.6	-1.6	0.6
Conv. 30-Year													
7.0	29-05	98-06	49bp	4.7	-1.0	0.4	1.7	2.2	0.6	0.3	4.9	-0.8	0.0
8.0	29-10	102-03	49	3.5	-1.6	0.4	1.7	1.1	0.4	0.3	4.1	-1.4	0.2
9.0	28-00	105-07	49	2.0	-1.5	0.6	1.4	0.0	0.1	0.2	3.2	-1.8	0.5
10.0	20-01	109-16	76	2.3	-1.1	0.5	1.7	0.2	0.0	0.2	3.5	-1.6	0.6

Source: Salomon Brothers Inc.

As shown in our recent paper, if effective durations are used for hedging, the error is approximately given by the change in each of the risk factors times its partial duration. Since in any given time period one or more of these factors will almost certainly change, the true test of a model is how well it performs on average over time (when changes in the risk factors will hopefully cancel). The paper gives historical results for Salomon's models.

Empirical Durations Are No Panacea

Some market participants have embraced empirical durations out of frustration with, or a lack of confidence in, model-based durations, perhaps due to an expectation that effective durations from a good model should always work well — in fact, as indicated in the previous section, because of the multiple risk factors that impact MBSs, actual and predicted price moves will almost always differ. Empirical durations are assumed to give a better indication of likely MBS price moves — after all, durations are based on actual market data! However, as discussed in our duration paper, significant deviations between effective and empirical durations are not necessarily a cause for alarm once a better understanding is gained of the statistical properties and limitations of such measures.

First, it should be noted that there are several different ways of calculating empirical durations. Figure 6 (again taken from the new duration report mentioned in footnote 2) shows various empirical durations for the last month of market data:[9]

Regular Empirical Duration is obtained by regressing daily percentage changes in price against daily yield changes in the ten-year Treasury. For GNMA 8s, for example, this is 3.5.

Updated Empirical Duration corrects the regular empirical duration for market changes over the last month. Since the market has rallied over the last month, regular empirical durations estimated using the last month of data will be too long. As shown in the recent paper, the correct adjustment is the difference between the *current* effective duration and the *average* effective duration over the last month. For GNMA 8s, for example, the current effective duration is 4.1, while the average over the last month was 4.3, a difference of -0.2, and hence the updated empirical duration is (3.5 - 0.2), or 3.3. *Investors who lean toward empirical durations should use the updated number*, as the regular empirical can be misleading after a significant market move (our astute readers will, of course, use the effective durations from Salomon's models).

[9] A detailed description of these duration types, as well as a discussion of their statistical properties, appears in the recent duration paper, cited in Footnote 1.

For reference, we also show two alternative empirical duration measures:

Relative Coupon Duration is obtained by regressing daily percentage changes in price for a given relative coupon, e.g., for the current-coupon or current-coupon +50bp, against daily yield changes in the ten-year Treasury. Using a fixed relative coupon (or fixed dollar price) is an attempt to eliminate the effect of changing interest rates on empirical duration calculations, but as discussed in the paper, the updated empirical duration is a better method for doing this.

Level Empirical Duration is obtained by comparing price levels against yield levels (as opposed to price changes versus yield changes). This method gives better results for illiquid securities such as high premiums, for which prices may respond with a lag to yield changes. For example, for conventional 10s, the regular empirical duration is 0.6. However, this is misleadingly low, and is due to a disconnect between daily Treasury yield changes and corresponding price changes on the 10s (which may occur with a lag and in response to several days worth of yield changes). The level duration of 2.3 is a better indication of long-term conventional 10% price behavior.

Figure 6. Empirical Duration Measures for Pass-Throughs

						1-Month						
									Empirical Durations			
	WAM	Price	OAS	Eff Dur	Eff Conv.	Px Change	OAS Change	OAS Corr.	Regular	Updated	Relative Coupon	Level
GNMA												
30-Year												
7.0	29-04	98-04	44bp	5.5	-1.1	1-21	-2	-0.51	5.2	4.9	4.9	5.3
8.0	29-10	102-10	50	4.1	-1.5	1-06	-2	-0.77	3.5	3.3	3.3	3.6
9.0	27-11	105-26	48	2.2	-1.8	0-26	-8	-0.45	2.1	1.7	2.0	2.5
10.0	20-09	109-24	79	2.4	-1.1	1-00	5	-0.76	1.3	1.1	NA	1.6
Conv. 30-Year												
7.0	29-05	98-06	49bp	4.7	-1.0	1-21	-3	-0.49	4.5	4.2	4.4	4.7
8.0	29-10	102-03	49	3.5	-1.6	1-06	-3	-0.50	3.3	3.0	3.1	3.2
9.0	28-00	105-07	49	2.0	-1.5	0-26	-7	-0.36	2.0	1.8	2.0	2.3
10.0	20-01	109-16	76	2.3	-1.1	1-00	-5	-0.82	0.6	0.3	0.6	2.3

Source: Salomon Brothers Inc.

Figure 6 also shows the correlation between daily OAS and ten-year yield changes **(OAS Corr.)** over the last month. OAS directionality, as measured by this correlation, is the major reason for discrepancies between empirical and effective durations. In particular, a negative correlation leads to the empirical duration being shorter than the effective. However, *daily directionality may not be relevant for longer periods such as a month*. For example, for GNMA 8s, the correlation of -0.77 implies a high degree of daily directionality; i.e., as rates drop, OASs widen, and as rates rise, OASs tighten. However, over the last month, even though Treasury rates have fallen by almost 40bp, the OAS on the GNMA 8s has actually *tightened* by 2bp. In other words, daily directionality tells us little about OAS changes over longer periods; as a corollary, it also means that empirical durations calculated using daily data can be *too low* as predictors of longer-term price movements (see the paper referenced in Footnote 1 for further discussion of this issue).