

## Valuation Commentary

### The Hunt for Duration

By Alex Levin

Whether practitioners use our analytics to delta-hedge, to report hedge effectiveness under FAS-133, or to compute hedge ratios when taking short TBA positions against a pipeline origination, they focus foremost on a single analytical outcome - Effective Duration (ASA option-adjusted duration, OAD). Most requests for analytical consulting and most questions concerning valuation results also revolve around the reasonableness of this measure.

Much like most of our clients, we pay thorough attention to the OAD derived by our models. We have our own elaborated in-house OAS system that is heavily employed in the AD&Co business regimen as well as some client environments. This OAS system is used to generate our weekly market analysis reports. Last, but not least, it helps in benchmarking the valuation work done by our diverse clientele. Let me postpone my arguments and jump right to the conclusion: AD&Co analytics, when used properly, allows modeling the OAD for various MBS instruments accurately and inline with the market. This “proper” usage involves not only bug-free settings, but also a deep understanding of the limitations and extensions of the OAS method.

#### ***What does the OAD depend on?***

Obviously, the **prepayment model** is one of the key analytical ingredients driving the interest rate risk measurement. It is very important that the AD&Co prepayment model setup is correct. The cause of a suspicious OAD could be from an incorrect setup of this model. For instance, the model expects to get the gross coupon of the MBS in question along with the net current coupon market rate that is often quoted by Bloomberg (MTGEFNCL, etc.). This requirement has been commonly misunderstood and confused. Sending a wrong market index (say, gross instead of net) materially slows down prepay speeds and extends OADs. Improper mapping of instruments to loan types can and did cause trouble for some users.

Our latest prepayment model, AD&Co v5.2 – the Unified model, has an interesting new feature - ARM type auto-selecting. An important input when modeling an ARM is the pool’s initial period. In the Unified model we can take in this input and find the right branch internally (3/1, 5/1, etc.) rather than getting it from the user. This requires caution however. If the initial roll is set incorrectly, not only will the scheduled amortization suffer, but the results from the prepayment model will be incorrect as well.

If the prepayment model is setup properly, the next concern is whether to use or ignore the enhanced dataset (loan size, LTV, geography, etc.). Pools with low loan sizes, or ones that originated in NY, FL or TX are slower and have “longer” than average OADs.

The **valuation method** is closely related to the use of the prepayment model. OAD is a valuation measure that is not generated by the prepayment model itself, unlike the average life or the equivalent CPR. Complaining that an OAS system delivers a dubious OAD assumes that the constant-OAS method must correctly quantify the risk. That is, if interest rates move up or down, OAS levels will remain unchanged. This does not happen in the real world, in part because the OAS levels themselves are associated with bearing prepayment model risk priced by the MBS market (Levin [2004a], Levin and Davidson [2005]). PrOAS, or simply OAS to a risk-neutral prepayment model, can measure both risk and reward better. At the 2006 annual AD&Co conference, I referenced a case study of the Trust IO market. Observing Trust IOs from March to September of 2003, I concluded that the prOAS method, when compared to the OAS method, was better 4 times out of 5 in predicting price moves during this period of high volatility. For most of the IOs, the prOAS method simply dominated the OAS in accuracy. IO managers who relied on the OAS method systematically under-hedged.

To implement AD&Co prepayment risk-neutrality you generally just need to change both the refinancing tuning and the turnover tuning. These can be found weekly on our market analysis WEB pages. Some of our OAS clients have adapted the prOAS views, but many still naively think the standard OAS method must do what they like to see – accurate prediction of price moves.

**Term structure model and volatility selection** also play an important role in OAD. First, volatility should be tied (“calibrated”) to the market. Every MSR manager knows that the static valuation will drastically exaggerate effective duration. But what is the static valuation? It can be viewed as a zero volatility OAS method. Hence, if volatility is incorrectly selected, the OAD generated will be unreasonable – there is no need to suspect a fault in the prepayment model.

Once the role of volatility is understood, volatility specification must be properly selected. This is where we usually refer to the interest rate model choice, conscientious or not. Our study (Levin 2004b) showed that swaptions are traded as though swap rates are almost normally distributed, and this trend became even more apparent in recent years. The use of a lognormal model is not defensible anymore and extends duration artificially. The next table quantifies the difference under different market conditions (same current-coupon rates).

## **Exhibit 1. Effective Duration under different rate models and market conditions**

	<i>actual flat curve - 3/23/2007</i>				<i>same volatility 10-2 curve steeper by 200 bps</i>				<i>same curve volatility is up 50%</i>			
<b>Fixed FN TBAs</b>	<b>HW</b>	<b>BK</b>	<b>diff</b>	<b>%</b>	<b>HW</b>	<b>BK</b>	<b>diff</b>	<b>%</b>	<b>HW</b>	<b>BK</b>	<b>diff</b>	<b>%</b>
4.5	5.46	5.85	0.39	7.1%	6.30	6.39	0.09	1.4%	5.16	5.54	0.38	7.3%
5.0	4.71	5.05	0.33	7.1%	6.27	6.33	0.07	1.1%	4.62	4.87	0.25	5.4%
5.5	3.61	3.89	0.28	7.9%	5.75	5.83	0.08	1.4%	3.82	4.00	0.18	4.8%
6.0	2.19	2.42	0.23	10.5%	4.74	4.88	0.13	2.8%	2.72	2.92	0.19	7.0%
6.5	0.84	1.06	0.22	26.6%	3.14	3.42	0.28	8.9%	1.60	1.86	0.26	16.5%
<b>new 5/1 hybrids</b>												
5.0	2.20	2.36	0.16	7.3%	2.68	2.87	0.19	7.2%	2.15	2.45	0.30	13.8%
5.5	1.80	1.96	0.16	8.8%	2.33	2.55	0.22	9.3%	1.79	2.09	0.30	16.7%
6.0	1.40	1.54	0.14	10.0%	1.96	2.19	0.23	11.9%	1.44	1.72	0.28	19.2%
6.5	1.16	1.29	0.13	11.0%	1.68	1.91	0.23	14.0%	1.24	1.49	0.25	20.0%
7.0	1.04	1.16	0.11	10.9%	1.49	1.72	0.23	15.6%	1.16	1.37	0.21	18.1%

The explanation of the difference between the HW results and the BK results lies solely in the volatility specification. When measuring duration we shock rates up and down. Absolute volatility remains unchanged in the HW model, but gets proportionally inflated or deflated in the BK model; so does the option cost. Hence, when rates move up (or down), the MBS value experiences a larger drop (or gain) under the BK model than under the HW model, i.e. has a longer OAD. For fixed-rate MBS, this effect is stronger when the curve is flat or inverted in the view of forward moneyness of the prepay option. For ARMs, the inverse is true because of the reset caps – they get hit more likely with upward forward paths.

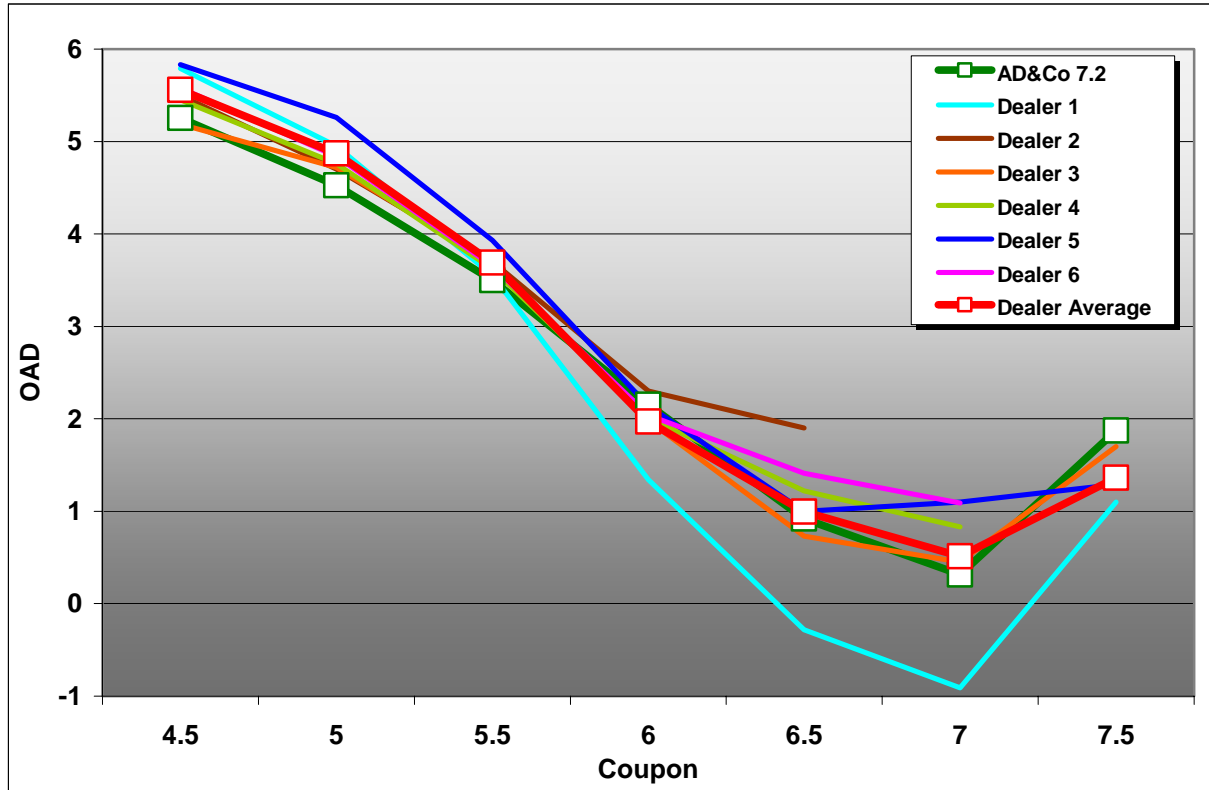
**Market conditions** play an apparent role in OAD as seen from Exhibit 1.

- With MBS rates unchanged, a steeper curve makes MBS look “longer” because forward prepayments are slower.
- Market volatility level is a factor too. Usually a higher volatility shortens OAD for the discounts and lengthens it for premiums. Explanation lies in the refinancing S-curve. Discount MBS will look shorter in a volatile market because their life can’t extend anymore – it can contract however. For the very same reason, IOs taken from discount pools are concave; in contrast, IOs taken from premium pools have a positively convex valuation profile. Due to the presence of reset caps (usually remote) in hybrid ARMs, the difference between HW and BK is stronger when volatility is high.
- Price/OAS levels are somewhat important because higher discount factors make the “gravity center of the cashflow mass” look closer. A zero-coupon bond’s duration is always equal to its maturity, but any coupon-paying instruments would have shorter interest rate sensitivity when discount rates are high.

### **AD&Co versus dealers**

Exhibit 2 below compares effective durations reported by 6 major MBS dealers (not named in the exhibit) and AD&Co; the data was compiled by Sanjeeban Chatterjee, our prepayment modeler. You can see here that AD&Co is inline with the mainstream market.

**Exhibit 2. OADs for FN TBAs reported by AD&Co and 6 major dealers (March 16, 2007)**



Our deviation from dealers’ average is barely sizable. In fact, the dealers deviate more from each other. In part, this comparison may not be exactly fair as we employed the median WAC and WAM assumptions as a starting point. Of course, had our analytics been flawed, we would not have been able to come close to the dealers’ output like we did. A relevant reminder - AD&Co monitors and analyzes market trends carefully, but makes no special efforts to replicate dealers’ analytical results.

***OAD and Empirical Duration***

OAD is often compared to the “empirical duration” obtained using the last 30 or 60 days. Change in price is regressed versus market rates thereby revealing regression’s slope. Empirical durations are often published by dealers. It is a model-free measure making it attractive for delta-hedging. No particular factor model (OAS, prOAS) is required - the hedge will succeed if the historical relationship between two (or more) instruments remains intact in the future.

Here comes the root of the trouble. Hedging is done to reduce future risk. For an empirical duration to serve an ultimate gauge, it has to link the correct instruments and be computed with a relevance to the current rates and not past rates. The historical regression should therefore reflect MBS convexity (to predict duration change) and include several points of the yield curve.

Levin [2001] gives the following counter-example: Let us assume that an MBS is linked to an average of the 2-yr, 5-yr, and 10-yr points. Assume further that these 3 rates have the same volatility and a high, but imperfect, 85% cross correlation. If we select only one point as the explanatory factor (say the 10-yr rate), then the MBS price will exhibit a  $100\% - (85\% + 85\% + 100\%)/3 = 10\%$  systematic directionality. That is, a 4-yr duration MBS will only show a 3.6-yr empirical duration. For example, LehmanLive.com publishes the 60-day empirical duration to the 10-yr point (swap and Treasury); the field was negative for high-premium TBAs when the curve twisted in 2004-2005.

Empirical duration, as attractive as it sounds, has to be used with caution and measured with rigor.

### **OAD via Monte-Carlo**

When running Monte-Carlo, price (or OAS) is found with a sampling error; so are the Greeks. This prompted us to study the OAD accuracy when running Monte-Carlo. I am not attaching the derivations but the answer is,

$$RMSE(OAD) = \frac{1}{\sqrt{n}} \sqrt{C^2 \sigma^2 + 0.5K^2 \sigma^4}$$

where  $n$  is the number of trials (rate paths),  $C$  is convexity (without conventional division by 100),  $K$  is kurtosis (third derivative of price divided by price), and  $\sigma$  estimates the standard deviation of the rates over the average life of the instrument.

As is the case for all other Monte-Carlo results, the OAD error is inverse to the square root of the number of paths,  $n$ . The kurtosis term is usually modest when the instrument is option-free or contains smoothly exercised options. This is not the case with PACs, TACs, supporting bonds, and complex CMOs, where various triggers and jumps can shift the cashflow order. If convexity is high, it is only a half-trouble. If it behaves badly (unsteady), it may lead to a large kurtosis and a poor OAD accuracy. Even if you deal with an ABS floater and think its duration is close to zero and easy to assess, you may be surprised to learn that the deal's exotic structure requires a lot of paths to run.

### **References**

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