
Option-Adjusted Spread Analysis: Going Down the Wrong Path?

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Option-adjusted spread analysis can be a useful tool for portfolio management, but taking it too far may be a dangerous thing. OAS analysis of individual securities is often less useful than scenario analysis. In addition, most portfolio OASs are incorrectly calculated.

OAS analysis would be much more useful if it provided more information on the distribution of resulting prices. Sensitivities to prepayment levels and volatilities could also enhance OAS analysis as an investment tool.

Babbel and Zenios recently outlined the basic advantages of option-adjusted spread (OAS) methodology, as well as a number of its shortcomings.¹ I believe there are even more fundamental problems with OAS. Before discussing them, I provide a brief review of OAS's good points, as well as the basic methodology.

BACKGROUND

Option-adjusted spread analysis is generally accepted as the "state of the art" in analyzing complicated securities, especially those with uncertain cash flows. It is certainly preferable to comparing securities on the basis of their yields to maturity, a practice common not very long ago. It also offers theoretical advantages over scenario analysis, although an argument will be made later that scenario analysis offers some practical advantages and more insight to the portfolio manager.

OAS is the *theoretically* preferred approach for several reasons. OAS analyzes a security over a large number of interest rate paths, both favorable and unfavorable. If these paths are representative of future possibilities, OAS appears to provide a summary of almost all possible scenarios. Furthermore, in OAS methodology the interest rate paths are "calibrated" to the current yield curve, eliminating any bias in the selection of scenarios that might occur in scenario analyses.² The OAS approach recognizes the security's cash flows along each path, hence incorporates the optionality of cash flows into the analysis.

There are nevertheless problems in the implementation and especially the interpretation of OAS, which can result in a distorted picture of the behavior of securities and portfolios. As a result, it should never be relied upon as the sole measure of the value of either securities or portfolios.

Basic Description of OAS

In the OAS approach, a series of future interest rate paths (each equally likely) is generated according to a strict set of constraints. This can involve various levels of complexity. The interest rates can be generated by a single-factor model (short rates only) or by multifactor models that simultaneously model several points on the yield curve through time. Volatility can be assumed constant across time, or can be made a function of time (or rate level or maturity). Rates can conform to several possible distributions and can be constrained from reaching severe extremes.

The security is then modeled along each rate path, and an appropriate set of cash flows (for every point along the path) is determined. For noncallable securities, this is a trivial exercise, but for mortgage-backed securities and corporates with option features, some algorithm is required to determine what the level of prepayments will be, or whether the bond will be called, put, etc. This process is repeated for every possible interest rate path.

Along each path, the cash flows are discounted at the Treasury rates plus a spread to determine the theoretical "price" of the security. Let us call this "price" the "path and spread-specific price," or PASS price. The OAS process

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generates a series of PASS prices, one for each path at a given spread. If the average of the PASS prices equals the security's actual price, the spread that was used is, by definition, the option-adjusted spread. If the average price does not equal the security's price, another spread must be chosen, new PASS prices determined and averaged, and so on, until the OAS is found.

Figure A shows two stylized paths of short-term Treasury rates that might result from the interest rate modeling process. The dashed lines illustrate how these rates are modified in the iterative search process to determine the OAS. In this figure, the two paths generate the prices shown at the particular trial spread. Figure B expands Figure A to show those two rate paths in the larger context of many rate paths and calculated present values. All the prices shown on the left (and the many hundreds more that can't be shown on this diagram) are averaged for comparison with the current price.

Figure A. Discount Rates = Treasury Rates + OAS "Trial" Spread

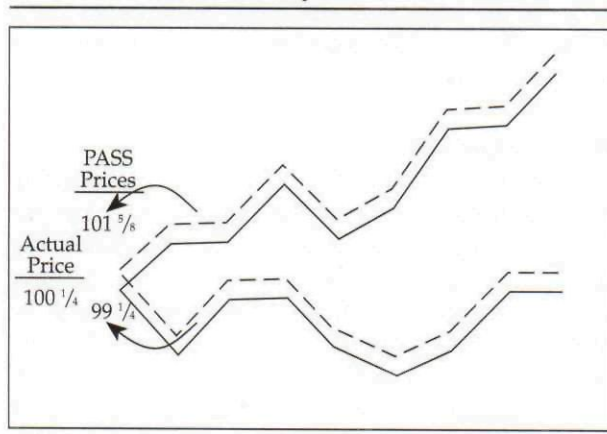
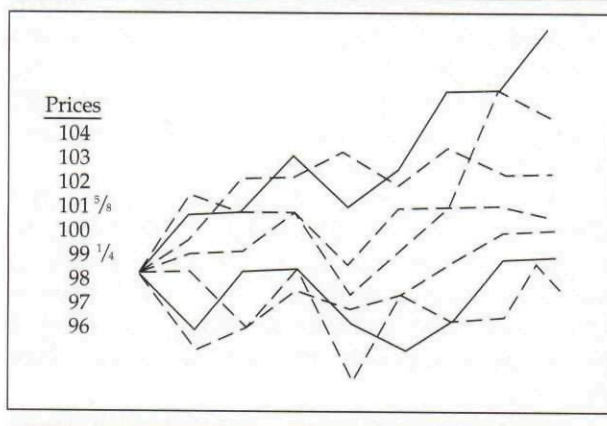


Figure B. Many Rate Paths



This description should make one thing clear: It is extremely unlikely that a security will actually earn its calculated OAS. In fact, depending upon the particular path of rates that actually occurs, the security may wildly outperform or underperform Treasuries, thus realizing either a very high or even a negative spread, regardless of its calculated OAS.³

The architects of the various OAS models that abound on the Street never intended the OAS to be viewed as a "yield takeout" over Treasuries. Because it's the result of an averaging process, OAS represents a summary of what the future may hold, not a promise. Nevertheless, numerous investors all across the sophistication spectrum have misinterpreted the output as some sort of spread that's locked into their portfolios after purchase. Some institutions have memos in their files documenting the "profit" on a purchase as the difference between the OAS and the funding spread above Treasuries.

ONE LIFE, ONE PATH

Suppose for a moment that your OAS model can generate interest rates with such uncanny foresight that one of them (you don't know which one) is guaranteed to match actual rates precisely. While such "accuracy" is no doubt desirable (we obviously wouldn't want a model that guarantees that none of its paths will actually occur), it does not necessarily improve the investment selection process.

Now suppose the model produces an OAS of 100 basis points, and that this is considered very attractive based on the security's maturity, quality, liquidity, etc. The security could nevertheless prove to be a very poor investment. Suppose the actual path is one for which the OAS model produces a PASS price well below today's price (one of the lower prices in Figure B). With 100% foresight, one would not pay the market price for the security, but only the lower, calculated PASS price, after discounting the security's cash flows at the known Treasury rate path plus 100 basis points (or some lower "certainty-equivalent" spread).

Unfortunately, an investor relying on OAS analysis would base the investment in the security on the average PASS price, not the specific price from the underperforming path. Certainly, no one expects to be able to predict the future, but even when OAS analysis incorporates the actual future, it does not necessarily improve decision-making.

Perhaps the greatest shortcoming of most OAS decision-making (aside from the technical

details of the models) is the fact that the distribution of PASS prices is not usually provided. This distribution would be of immense value to portfolio managers as a guide to the risk of the security. If PASS prices were tightly concentrated, the current security price would be considered fair for a wide range of ultimate paths. Extreme outliers could be examined to determine the paths that generated them, warning managers about the dangerous scenarios. This kind of knowledge would be even more useful in the portfolio context. Asymmetries in return, naturally useful to the portfolio manager, would also be discernible from the distribution pattern of prices. The ability to "reverse trace" returns to the scenarios that generated them is important to portfolio managers and is one of the reasons that scenario analysis is so useful.

The Weather Forecast

It is extremely difficult to measure the effectiveness of an OAS model objectively. After all, the calculated OAS is based on possibly thousands of paths, whereas the actual return on the security is based on one. This is not unlike the local weather forecast. If the forecast calls for 20% chance of rain, how do we measure its accuracy? At any given spot, it either rains or it doesn't; that is, the *ex post* "probability" is either 100% or 0%. If it doesn't rain, was the forecast wrong? If it does rain, does that imply that the probability of rain should have been higher?

What exactly do OAS models measure? They do not actually value an option in the usual sense of option valuation. Instead, they provide an actuarially determined yield effect. This is not meant as a criticism: The models were developed for situations in which the options were so complex or interrelated that simpler models could not provide meaningful results. Unfortunately, the interpretation of OAS often implies that the approach does provide a specific option value, which can be subtracted from the security's yield to provide an option-free "true" spread. If this were so, the OAS might represent the true credit spread of the security. But investors exact a price for uncertainty, and the uncertainty of the option-burdened security should cause it to trade at a higher spread.

This brings up another question: What does spread mean in this context? The uncertain life of the instrument, attributable to its features, makes difficult any comparison of its option-adjusted spread with that of another security. If there is a term structure of OAS, and different maturities

(or, more likely, different effective durations) provide different spreads, to what should this spread be compared?⁴

Measurement is further complicated because OAS is a very dynamic value, responding to changes in the level and shape of the yield curve, volatility, prepayments, credit spreads, liquidity, etc. And as a "life" measure, based on all of a security's cash flows, OAS may not be able to tell us much about total returns over some shorter horizon. Over the short run at least, returns can be very directional, and an appropriate benchmark may be hard to determine.

The returns on an interest-only strip with a duration of -25, for example, could be compared with the returns of a similar-duration Treasury portfolio. But what has a duration of -25? We would need to combine a short position with cash to achieve the negative duration. For a \$10 million position, we could perhaps short \$20 million of 30-year Treasuries, or roughly \$35 million of the 10-year, etc. Further complicating the task is the fact that other OAS models might calculate an option-adjusted duration of -10, or even -5! The lack of an objective, unambiguous benchmark makes OAS performance measurement more an art than a science.⁵

Average OAS or Portfolio OAS?

The OAS of a portfolio is usually calculated as the weighted average of the OASs of the component securities. This introduces several problems, depending upon why the investor wants to know the average spread. If the investor simply wants to know the daily contribution to return at the current time, this weighting is correct, in the same way that a market-weighted yield provides that information. For other uses, however, this weighting may be incorrect.

When an investor wants an average yield that approximates a portfolio's internal rate of return, the yields must be weighted by both durations and market weights. When the investor wants the average option-adjusted spread to provide the analogous information for spread, he should use the same duration and market weightings.

Even if the proper weightings are used, the OAS calculation is still fraught with traps for investors. Aside from all the modeling problems and the averaging problems, the individual securities may vary dramatically from one another along any given path. Or, possibly worse, they may not!

Consider a two-asset portfolio with equal

amounts invested in each security. Suppose that each has an individual OAS of 100 basis points, but each performs much better along certain paths than others. If the securities are highly correlated, they will tend to perform well together along certain paths and poorly together along other paths. Thus the portfolio returns (along any path) will tend to look like the individual security returns for those same paths. The OAS of the portfolio will be 100 basis points, but the spreads of the portfolio will vary widely across different paths.⁶

If the securities do not act together, a diversification effect occurs, and the worst portfolio performance will not be as bad as the worst individual security performance. This is fairly obvious; the point is, the standard weighted portfolio OAS will still be 100 basis points (although the "true" OAS may be very different), and will completely mask the true performance profile of the portfolio.

The situation is even more complicated when the individual securities have very asymmetric PASS price profiles, which is very likely with mortgage derivatives and other event-driven security types. If the two (negatively correlated) securities provide performance home runs along a few different paths (for example, the high-rate paths for one and the low-rate paths for the other), but mediocre performance along the others (the less extreme rate movements), the portfolio performance profile could look like a bathtub—high spread returns at each end of the path spectrum and mediocre (or even negative) performance along the middle paths. The "expected" spread of 100 basis points would almost never be earned; the investor would most likely have mediocre returns, unless a "home run" scenario unfolded.

Given sufficient computer power and memory, one can correctly calculate portfolio OAS by following the same algorithm for the portfolio as for individual securities. Along any given path, the cash flows for each individual security are determined and then summed together at each node in the interest rate path. These combined portfolio cash flows are then discounted at the trial spread to determine the portfolio PASS value for that path and spread. This process is repeated for all paths, then the total portfolio values are averaged to determine if they match today's actual portfolio value. If the average value matches the actual, then the spread is the portfolio OAS; otherwise, another spread will have to be chosen and the discounting repeated.

If portfolio OAS is calculated as described above, and if portfolio managers are given the

distribution of portfolio PASS values at the OAS (as suggested above for individual securities), the information will be meaningful. Any diversification effects will be embedded in the distribution. High correlation of securities will result in a wider distribution of portfolio values than low correlation.

A wide distribution suggests that the realized spread of the portfolio (along the path that ultimately occurs) is likely to vary significantly from the calculated OAS. A perfectly diversified and hedged portfolio would be concentrated at only one value. Such information will certainly be of interest to the portfolio manager.

MORTGAGE-BACKED SECURITIES

Mortgage-backed securities (MBS) seem to be particularly appropriate subjects for OAS analysis because of the complexity of their cash flows and the fact that the flows are path-dependent. In practice, however, most MBS OAS models have one particular flaw: The flows are determined by a prepayment model that is deterministic at each node, instead of probabilistic. While a prepayment model is obviously needed to generate the flows, specifying the *exact* flow rather than sampling from the possible outcomes makes the OAS insensitive to possible real-life variations in prepayments.

Investors will often run an OAS at several multiples of a prepayment model. For example, the cash flows may be generated at 100% of the model and then rerun at 90% and 110% to determine sensitivity.⁷ This measures the sensitivity of the OAS to consistent misestimation of the prepayments, however, not to the random fluctuations around the model's predictions.

A better approach, but one that requires more computing power, would be to use a probabilistic model and then increase the number of runs through the paths in order to capture the distribution of possible prepayments at each node. This "double stochastic" approach will be more accurate in capturing the reality of variable rates and prepayments.

Event-Driven Securities

Certain MBS derivative securities, such as jump-Z tranches of a collateralized mortgage obligation (CMO), present special problems for the OAS model.⁸ Jump-Z bonds are support bonds that provide a cushion to the planned amortization classes (PACs) in the CMO. However, under certain circumstances, such as when average or recent prepayment rates exceed a certain level, the

jump-Z will suddenly jump in front of the other classes in terms of principal-payment priority. The actual level at which the trigger is set is somewhat arbitrary.⁹

The problem for the model is that the performance of the security depends critically on whether the event occurs or not; the prepayment model within the OAS model must be absolutely correct to capture the true nature of the security. Of course, the same event that triggers the jump-Z will also affect the PACs in the CMO, so even the "safer" tranches have substantial model risk.

There are now a whole variety of event-driven securities outside of the mortgage market, from step-up coupon bonds to various options and complicated swaps. The events that affect these instruments are not necessarily related directly to the interest rate path, either; they may be a change in credit rating or some other exogenous variable.¹⁰ The OAS model cannot capture the effects of events that are not dependent on the interest rate process. For example, a downgrading may not be completely independent of the interest rate level, but it probably cannot be modeled as a function of the rate path. Downgrading differs from prepayments in this; the primary determinant for prepayments is the level and path of rates, so the OAS approach can model the effects of prepayments, even if not perfectly.

The modeling process is made all the more difficult when multiple currencies are involved. Consider a yen-based investor attempting to determine the yen-based OAS of an investment in U.S. corporate or mortgage-backed securities. Not only must the interest rate paths in yen have all the desirable qualities of the single currency model, but for each possible change in rates in the host currency, the potential changes in the dollar must be modeled. Then a prepayment model must be layered onto the dollar interest rate paths.¹¹

SCENARIO ANALYSIS TODAY

Scenario analysis is more sophisticated today than the up-and-down parallel shifts assumed only a few years ago. Now it is possible to change the shape of the yield curve and quickly incorporate many of the resulting effects. For the manager whose portfolio may be sensitive to such changes, discovering which scenarios are particularly dangerous, and quantifying the effects, is a very useful exercise. Checking the returns on a variety of scenarios can lend support or provide an early warning. Rather than losing all the information in a black box, the mortgage manager can control

everything, from the prepayment vector to the exact timing of the change.

Corporate managers can incorporate beliefs about the likely levels of rates that will induce a call and can factor in the timing of the call as well. Although none of the managers' scenarios may accurately reflect the future, together they provide better information than an OAS model. This is not meant as a criticism of the OAS approach, which is intended to summarize all the available information in a single value description. Such a distilled measure obviously cannot provide all the information that exhaustive scenario analysis can. And the scenario approach has its own costs in computer time and personal effort (as well as its own biases in scenario selection).

In the case of CMOs, scenario analysis allows the portfolio manager to specify both the terminal yield curve and the prepayment experience. Prepayments can be varied to see the point at which particular tranches start to behave erratically.

There is, however, a catch to the use of scenario analysis as an alternative to OAS analysis. Scenario analysis requires some assumption about the terminal price or yield spread of the security in question. For mortgage-backed securities, or any security with an option component, a traditional yield spread doesn't make sense because the duration of the security varies, hence the point on the yield curve from which the spread must be measured is unknown. Many investors rely on a constant OAS as the pricing spread, which presupposes some correctness and appropriateness in the measurement of the OAS in the first place.

Improving OAS

The rapid acceptance of OAS as an analytical tool is remarkable in light of its complexity. It provides a good example of how a sophisticated model can work its way into the mainstream, where its limitations are not completely understood.¹²

Several enhancements would eliminate some of the ambiguity of OAS results. First, uncertain events along the interest rate paths, such as bond calls or prepayments, should be treated as uncertain events, with probabilistic models used in repeated trials along the paths.

Second, the distribution of PASS prices should be provided in a usable form.

Third, while OAS models are usually run several times to estimate option-adjusted duration, sensitivities to prepayment levels and volatility should also be provided. More sophisticated cor-

porate bond models could also measure sensitivity to call risk as affected by changes in corporate tax rates, management's desired "efficiency" in refinancing, etc.

Fourth, portfolio OAS should be calculated as if the portfolio were one security; that is, the cash flows from all securities should be aggregated at each node prior to discounting, so that the resulting OAS (with all its other problems) can be

interpreted in the same way as a single security OAS.

One particularly useful area of future research would be the measurement of performance of high-OAS portfolios versus their lower-OAS counterparts. This research would provide more information on the usefulness of the OAS (estimated over the entire life of the security) to managers with shorter horizons.¹³

FOOTNOTES

1. D. Babbel and S. Zenios, "Pitfalls in the Analysis of Option-Adjusted Spreads," *Financial Analysts Journal*, July/August 1992. The authors note the following pitfalls. (1) OAS is model-dependent. (2) Embedded model assumptions are often chosen for convenience rather than "their ability to capture the richness of reality." (3) The OAS is an averaged number, averaged across paths and through time. (4) Adding a fixed number of basis points to all rates results in subtle changes to the properties of the distribution. (5) OAS ignores some of the options, such as the default option. (6) There are some abuses in practice, such as using different volatilities for different types of bonds. (7) Ranking securities by OAS has some of the same problems as ranking them by yield to maturity.
2. That is, the rates for any given "node" are centered around the forward rate for that time period. In addition, the structure of rates is chosen to be "arbitrage-free."
3. The OAS methodology described above is based on an average of prices. There are several reasons for this, ranging from technical preference to convenience. The approach could also use average spread instead of average price. In this approach, each path would be evaluated to determine its spread, given today's price, and then the spreads would be averaged.
4. See Babbel and Zenios, "Pitfalls," *op. cit.*
5. See, however, "The Predictive Power of OASs: An Out-of-Sample Test," *Mortgage Market Review*, August 22, 1991, and Lucchesi, Ochmann and Smith, "Another Look at Option Adjusted Spreads," *Federal Home Loan Bank of Dallas Quarterly*, Summer 1989.
6. This "spread" refers to the spread over (or under) Treasuries that the security actually provides, based on today's price and the specific path of rates. While returns will naturally vary based on the direction of interest rates, the spread could be reasonably constant or could exhibit wide variations across paths.
7. Note that this refers to a multiple of a particular rate and path-dependent model, and does not refer to 90% and 110% PSA.
8. Actually, they present problems in the interpretation of the output of the model. The model will handle the "event" however it is programmed to handle it.
9. In fact, the trigger need not be related to prepayments at all; it could be tied to some Treasury rate reaching a particular level.
10. For example, a dealer could create a "home team" tranche that jumps if a particular team makes it to the Super Bowl or Final Four.
11. Alternatively, the dollar-based interest rate paths generate the associated cash flows, which are then discounted by a yen-based rate, which is somehow modeled to the dollar rate paths.
12. After this article was submitted, a large (\$1.6 billion) hedge fund invested heavily in mortgage derivatives was forced to liquidate, having lost all its capital. The portfolio was supposed to be market-neutral, with an advertised return of 15% to 18%. Because of the portfolio's complexity, the managers presumably relied on OAS models to measure security attractiveness and volatility. The abrupt collapse of the inverse floater market, culminating in the collapse of the fund, vividly demonstrates the limitations of the models.
13. I thank Martin Leibowitz for his helpful comments.

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