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*Expert guidance through the complexities of FAS 123R*

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With the effective date of FAS 123R fast approaching for most companies, we at FAS123 Solutions, LLC thought that many companies would benefit from the following discussion of two crucial topics. The first topic concerns comparisons of Black-Scholes to other models, and the second is the estimation of volatility under FAS 123R. We would be delighted to hear your comments or questions. Please visit our website at **www.FAS123Solutions.com** or call us at **1-800-732-0834**.


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## Estimating Volatility for Public Companies Under FAS 123R

### Introduction

In practice, under the old FAS 123, estimating volatility usually amounted to a mechanical process - simply using the historical volatility corresponding to the expected term of the option without considering any other information. Under FAS 123R, by contrast, this mechanical process should never be more than a starting point in the estimation process. In fact, in the original exposure draft, the Board went so far as to say that a company using only this simple mechanical process without also considering the extent to which future experience was reasonably expected to differ from historical experience "would not comply" with the new proposed standard.

### What is Volatility?

Intuitively, stock-price volatility is the degree to which the stock price "bounces around." Very stable stocks have low volatility; very risky stocks with big price swings have high volatility. Note that a stock with a steadily rising (or falling) price can still have a low volatility - indeed a stock that increased (or decreased) in price by 1% every single day would have a zero volatility. The reason for this is that volatility is a standard deviation of the return on a stock, and so any stock that moved in exactly the same way each day would have zero volatility. Volatility is generally reported as an annualized percentage. A stock priced at $30 with 50% volatility would have approximately a 2/3 chance of ending the year with a stock price between $15 and $45, while one with 20% volatility would have a 2/3 chance of ending the year between $24 and $36.

### Why is Volatility Important?

Option valuation, whether with Black-Scholes, a lattice model or a Monte Carlo simulation model, is quite sensitive to changes in volatility. Expected term is the other significant driver, but expected term will not change over time as frequently as volatility.

For a single Black-Scholes valuation, one estimates only a single volatility; for a lattice or Monte Carlo simulation model a term structure of volatility - multiple estimates corresponding to different terms implicit in the model - needs to be considered.

### Understanding Historical Volatility

Calculating a historical volatility for a stock is easy. One needs to decide over what historical

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## Thumbs Up or Down for Black-Scholes?

### Introduction

At FAS123 Solutions we have performed model comparisons for virtually all of our valuation clients. We observe that in a fair comparison Black-Scholes values are not necessarily higher than the valuations produced by alternative methods. The perception that Black-Scholes overstates employee stock option values is typically based on improper estimates of *expected term*. An informed comparison between Black-Scholes and alternative valuation models depends on sound and consistent estimates of expected term.

Let's take a step back. For many companies there is a tension between the continued use of Black-Scholes for FAS 123R stock option valuation and the adoption of one of the alternatives - lattice models, or Monte Carlo simulation models. This dates back to the March 2004 FASB exposure draft, which stated a preference for lattice valuations. Fortunately, the Board backed away from the exposure draft position when it issued the final statement in December 2004. FAS 123R leaves it to each company to decide on an option valuation model. The tension remains though, and there are three reasons:

1. Companies wonder if Black-Scholes will continue to comply with the accounting standards for the foreseeable future.
2. If a company does choose to use one of the alternative methodologies, the decision is not reversible. There's no going back to Black-Scholes.
3. Black-Scholes has the reputation of overstating fair value.

With regard to the first reason, Black-Scholes will not be disallowed any time soon. As stated above, however, a company imposes a prohibition on itself by choosing an alternative to Black-Scholes because there's no going back in subsequent reporting periods. Therefore, companies should now be focusing attention on the question of whether or not Black-Scholes values are in fact high, and if so, whether the spread over alternative values is material.

The primary reasons that Black-Scholes values are higher than values from alternative models are twofold. Either expected term is estimated incorrectly and/or volatility term structure slopes upward. Upward sloping volatility term structure is a market-based phenomenon. Incorrect expected term is a valuation error. For Black-Scholes, the proper way to estimate expected term is to import the exercise and termination behavior of optionees into an appropriate model of the company's future stock price.

Consider the three steps in this process:

### Step One: Model Exercise and Termination Behavior

The best way to model early exercise is to distribute exercise probabilities as a function of primary factors - stock price variables and time elapsed after vesting. This can be done using regression analysis or a probability array. Historical time to exercise is not a supportable estimator of expected term.

### Step Two: Build an Appropriate Model of the Company's Future Stock Price

A model of the company's future stock price is the mechanism for converting voluntary exercise behavior and expected post-vest termination into expected term. The model must be risk-adjusted rather than risk-neutral, and must properly incorporate the term structures of interest rates and volatility for the company. Comparisons performed with risk-neutral expected terms are rigged for Black-Scholes to lose.

### Step Three: Import the Behavior into the Stock Price Model

Voluntary exercise behavior and expected post-vest termination from step one are imported into the stock price model from step two. This is done with an "intensity function," which measures the probability that an option reaches its term due to exercise or post-vest termination. If voluntary exercise behavior seems to be path-dependent (e.g., depending on stock returns or stock price highs), then the stock price model must be a Monte Carlo simulation.

### Detailed Discussion

***Step one***, modeling voluntary exercise, is the most difficult step. A simple but flawed model of voluntary exercise is the average historical time to exercise, which is almost surely less than the historical term. It excludes options that remain outstanding, options that expire worthless at the end of the contractual term and options that are forfeited out-of-the-money by terminated employees.

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◄ Estimating Volatility, continued

period to sample and how frequently to sample the stock price movements. In general it is appropriate to use daily stock prices based on the market close. For very low priced stocks this can produce volatility "noise" because of the bid/ask spread; in those cases the average of weekly historical volatility makes more sense.

The issue of what period to look at is more complex. As mentioned above, the standard begins with a "term-matching principle" - the historical period is matched to the expected term of the option being valued. Thus, for an option with an expected term of six years, the term-matching principle requires that one generally look back six years. FASB essentially set forth this matching notion to establish some consistent benchmark, though there is no statistical evidence put forward that supports expected term matching. There is clear evidence that contradicts the notion that long-term trailing volatility reflects long-term future volatility expectations by market participants. For example, consider an investment bank writing five-year and six-year

options struck at the same price on the same underlying stock; the option writing bank would almost surely use near identical volatility for the two options. The bank would typically look back no more than two or three years in considering historical volatility. Notwithstanding these considerations, the FASB term-matching principle remains the standard starting point for estimating volatility.

Many companies are aware of how the term-matching principle creates what might be viewed as an unreasonable burden as volatility generally has been declining steadily over the last five or six years.

### Modifying the Term-matching Principle

Paragraph A21: "Historical experience is generally the starting point for developing expectations about the future. Expectations based on historical experience should be modified to reflect ways in which currently available information indicates that the future is reasonably expected to differ from the past."

In practice, one needs to consider how a company has changed over the years before blindly using the term-matching principle. To the extent there have been major changes - for example, a transition to profitability, or a change in business or capital structure - it is not appropriate to mechanically use information from an earlier period that is no longer relevant for predicting the future.

### Understanding Implied Volatility

If a stock has traded options, then it is possible to run Black-Scholes "backwards" and calculate the volatility implied by the traded prices of the options. This is the stock-market's current prediction of what the stock's volatility will be going forward, and this makes it a better fit with FAS 123R's emphasis on the future rather than the past. Paragraph B86 states that the objective in estimating volatility is to ascertain the assumption about expected volatility that marketplace participants would likely use in determining a price for the option, and this is obviously a closer fit with implied volatility than with historical volatility.

Of course, implied volatility as an estimate of future expected volatility is not without its challenges. Most stocks do not have traded options with terms as long as the expected terms of employee options - two or three year terms are typically the maximum for traded options, and many companies have a maximum term of six months on options traded publicly on the company stock.

Another problem is that trading in long-dated options is often light - the bid/ask quotes do give substantial information, but without actual trades they are a less reliable source of information. One approach to light trading is to use implied volatility averaged over time - perhaps a month or an entire quarter.

### Staff Accounting Bulletin (SAB) 107

The SEC has given guidance about the use of implied volatility in SAB 107. The general principle is that if a company has actively-traded options of at least a year in length, then a company can exclusively rely on the implied volatility. A company can also use the implied volatility derived from options with terms of six months or longer, but cannot exclusively rely on the implied volatility from these options - a company in this case will also need to consider historical volatilities.

Because of the long-term secular decline in volatility generally, the estimates based on implied volatility are consistently and often materially lower than the estimates based on historical volatility going back four to six years. This creates three classes of companies - those with actively traded long-term options (LEAPS) who can rely completely on implied volatility; those with traded options with terms of six months to a year that can rely partially on implied volatility; and those without traded options at all which are forced to rely exclusively on historical volatility. The first class of companies will end up with lower estimated volatility than those in the second class, which in turn will have an advantage in reporting their employee stock option based expense over those companies with no quoted options at all.

### Conclusion

In general, estimating volatility under FAS 123R is going to require judgment in deciding the right balance between implied and historical volatilities and deciding whether the term-matching principle can be modified given the specific facts and circumstances of the company. A company will need to use a consistent methodology going forward, and so the initial determination requires much care. The auditors will play an integral part in this determination, as they will need to be satisfied with the methodology chosen by the company and its valuation experts.

◄ Black-Scholes, continued

*Auditors are well aware of historical time to exercise is not a supportable estimator of expected term for option valuation.*

Alternatively, one can use a *suboptimal exercise factor*. The assumption here is that all non-terminated employees exercise options at the same stock-to-strike ratio. FAS 123R includes examples with an exercise factor of two. Improved modeling uses multiple exercise factors or an array of probabilities. The best approach to modeling exercise behavior is non-linear regression analysis. The result of this econometric analysis is a model that predicts the probability of exercise by non-terminated employees as a function of stock price returns over various periods as well as proximity to vesting. At each point through the term of an option, the forecasts of the regression models are assumed to provide sufficient statistics for the exercise probability. That is, systematic drivers of exercise probability for employees that are continuing with the company are assumed to be measurable by the regression model. Any regression residual is the remaining exercise risk that cannot be hedged away by the company. Secondary factors can also be modeled. These include market conditions such as interest rates as well as demographics such as age or gender. In general, a company requires a sufficiently rich historical grant and exercise data set to perform regression analysis.

***Step two,*** constructing an appropriate model of the company's future stock price, provides a mechanism for converting exercise behavior and post-vest termination into an estimate of expected term. At their foundation, lattices and Monte Carlo simulation models are stock price models. They become option valuation models when they are set up as risk-neutral and backward induction or path-specific option cash flow risk-neutral discounting is performed. However, in estimating expected term, rather than performing option valuation, the model has to use "real-world" probabilities rather than "risk-neutral" probabilities, so that the simulated evolution of stock prices is governed by realistic expectations. Voluntary option exercise and employee termination rates are estimated using actual historical data and must be converted to an expected term in a realistic prospective framework. Finally, the stock price model must properly incorporate interest rate term structure and volatility term structure. The latter is based on historical and/or implied volatility.

It is worth noting that footnote 55 in FAS 123R highlights the fact that a risk-neutral model will not produce a realistic measure of expected term.

***Step three,*** importing exercise behavior and termination into the stock price model, is fairly mechanical once the first two steps have been properly implemented. The probability of voluntary early exercise and the probability of post-vest termination are incorporated in the stock price model as an intensity function or "hazard rate" at each point in time and for each stock price scenario. In the case of a suboptimal exercise factor, the model has an exercise barrier. The "intensity" below the barrier is simply the post-vest termination rate. In the cases where regressions uncover more sophisticated exercise behavior patterns by option-holding employees, the intensity function will be the probability of early exercise conditional on continued employment plus the probability of post-vest termination. Monte-Carlo simulation is necessary when the behavior patterns are path-dependent - that is, dependent not only on the current stock price but recent historical returns on the stock.

### Conclusion

Companies that plan to continue using Black-Scholes can still harness much of the potential of more sophisticated models in estimating expected term. The appropriate methodology is compliant, and generally results in valuations that are comparable to valuations with lattice and Monte Carlo simulation models. Valid comparisons require (1) effective modeling of voluntary exercise behavior and involuntary behavior prompted by termination; (2) constructing an appropriate model of the company's future stock price based on "real-world" probabilities; and (3) importing the employee behavior into the stock price model.