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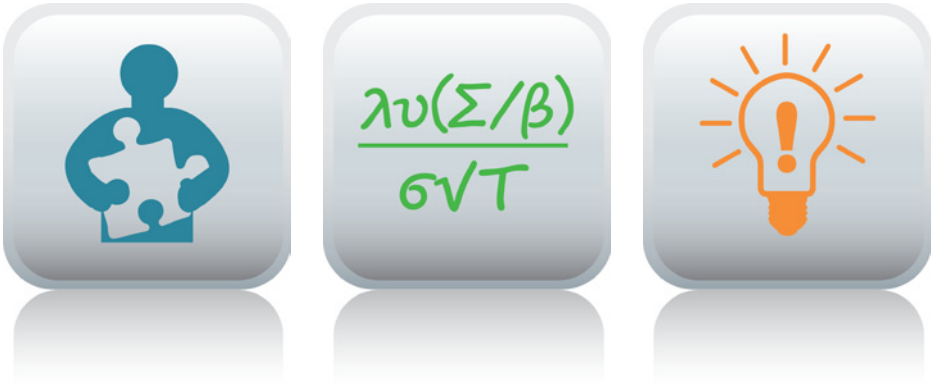
A MATTER OF LIQUIDITY

WHY THE BLACK-SCHOLES MODEL OVER-VALUES CONVERSION OPTIONS



ABSTRACT

Many preparers and auditors of financial statements use, or permit the use of, theoretical valuation models for valuing illiquid derivative instruments, even though the results are inaccurate and misleading.

The Black-Scholes method was the predominant model for many years, and was even endorsed by accounting rules prior to the introduction of FAS 157, even though it was never intended to be used for valuing complex securities or illiquid assets. Some have substituted lattice models or Monte Carlo simulation, making modifications or adjustment to attempt to compensate for illiquidity. The results are still inaccurate and misleading, because such models do not account for market-based activity.

While there is no standard model that is able to accurately take market discounts for illiquidity into account, the fair value of illiquid derivatives can be derived using secondary market data. This white paper will illustrate how wrong theoretical models can be when valuing illiquid securities. Comparing asset prices derived with theoretical models with actual, non-distressed trading prices for the same or similar asset(s) shows wide discrepancies.

How did the overreliance on theoretical models happen and what is the alternative? This paper puts valuation models in their historical context and includes a case study to demonstrate why the use of market data is superior to today's models.

> *"Black-Scholes fundamentally assumes that both the option derivative and the underlying reference security are both freely tradable and continuously traded."*

Before the introduction of the Black-Scholes model in 1973, there was no standard closed-form method for valuing derivative instruments, such as options. The Black-Scholes model solved this conundrum and paved the way for widespread use of derivatives by risk managers in the treasury departments of banks and by market makers. While the Black-Scholes model was predominantly used, lattice models and Monte Carlo simulation gained popularity as well. Over time, these valuation methods gained wider acceptance by users, preparers and auditors of financial statements.

In this paper, we highlight the valuation weaknesses of the models, especially their inability to accurately model illiquid assets. We will also describe how sole reliance on a theoretical model should not be considered compliant with U.S. GAAP if readily available information that has a significant impact on the valuation is ignored in the analysis. We will discuss the uses and misuses of theoretical models in financial reporting for illiquid derivatives, particularly when determining the fair value of conversion options. This paper will also review changes in the accounting environment that should cause reporting entities to limit reliance on Black-Scholes or other theoretical models.

The paper also presents a case study that outlines the difference between our approach, which relies on secondary market data, and a Black-Scholes-only approach. The fundamental characteristic of our approach is that it appropriately considers illiquidity, an element that Black-Scholes and other theoretical models are incapable of addressing. From a financial reporting perspective, this is critical, as U.S. GAAP fundamentally requires illiquidity to be a consideration in any valuation.

Black-Scholes is not designed to account for illiquidity. While other models may be adapted to some extent to address illiquidity by "fudging" the inputs to the models, they do not adequately address how illiquid assets are valued by real-world market participants. Black-Scholes fundamentally assumes that both the option derivative and the underlying reference security are both freely tradable without any restrictions and are continuously traded. It also assumes there are no limits on borrowing and shorting (*see the appendix*).

None of these assumptions is appropriate in the case of illiquid securities. Illiquidity arises when there is no trading at all, or when trading in a given market is considered inactive. An inactive market can be identified by examining trading volume, frequency and the amount of time between trades. In a private issuance, such as a Private Investment in Public Equity (PIPEs), the securities are often subject to sale and transfer restrictions or, in many cases, have no public market within which trading may occur. When illiquidity factors are relevant to a valuation, companies must adjust for these factors by developing an illiquidity discount in order to estimate fair value in accordance with the measurement date and exit price concepts set forth in U.S. GAAP. The resulting estimate is categorized as a Level I, Level II or Level III estimate, depending on, among other things, the degree of observability of the inputs.

These concepts require that fair value be estimated as of a point in time, referred to as the measurement date, and take into account and properly reflect all relevant facts and circumstances that characterize the market as of that date. A discount for illiquidity must consider relevant market transactions and whether these transactions occur in active or inactive markets. Many companies are unaware that comparable illiquid securities are priced in robust secondary markets and that a significant amount of information is available on the valuations of such securities.

"When illiquidity is a factor, companies must develop an illiquidity discount in order to estimate fair value in accordance with the measurement date and exit price concepts set forth in U.S. GAAP."

This paper reviews these theoretical models as used for valuing warrants, options, conversion options, and embedded derivatives. Conversion options are a component of convertible securities. Convertible debt is a hybrid financial instrument comprised of two components: debt and a conversion option; however, it may also include other embedded derivatives. Besides being used as a pricing mechanism by market makers and participants, many issuers of convertible debt rely solely on Black-Scholes or other theoretical models to estimate the fair value of the conversion option component for U.S. GAAP financial reporting purposes.

BEWARE!

Relying exclusively on standardized or theoretical models can lead to or result in the following errors and inconsistencies in financial statements:

- An overvaluation of the conversion option for a convertible debenture
- A misallocation between the debt and equity (conversion option) components
- An overallocation of value to warrants issued as "sweeteners" in multi-security deals
- A misstatement of earnings in the income statement

The last item is every CFO's worst nightmare and can be explained as follows. For accounting purposes, convertible securities are generally classified as either equity instruments or debt instruments. As long as the instrument is classified as equity, changes in fair value generally do not flow through the income statement. However, this classification may change and often does when companies amend deal documents to allow the company more flexibility; for example, in paying out cash instead of shares, or if the deal is inherently designed to alter its initial payout or conversion structure upon a triggering event or performance condition.

Deals often change. If the deal is modified so that cash instead of equity is paid out at conversion, the conversion option will no longer be deemed to have characteristics of equity and earnings will be misstated. In addition, any ratios or metrics based on amounts that are affected, including debt-to-equity, return-on-equity and earnings-per-share, will become inaccurate.

Any of these situations can lead to accounting irregularities, including undesirable earnings volatility for the issuer. If a misstatement is material, misuse of standardized or theoretical models may lead to a restatement of financial statements.

THEN AND NOW

U.S. GAAP includes three approaches for estimating fair value: cost, income and market. Prior to ASC 820, *Fair Value Measurements and Disclosures* ("ASC 820"), formerly FAS 157, *Fair Value Measurements*[1], fair value was defined and fair value disclosures were set forth and then codified in ASC 825, *Financial Instruments* ("ASC 825"), formerly known as FAS 107, *Disclosures about Fair Value of Financial Instruments*. These old rules

1 Now codified in ASC 820, *Fair Value Measurements and Disclosures*

"Under FAS 157, the valuation methodology must properly consider all facts and circumstances that affect fair value…"

provided an endorsement of the Black-Scholes and binomial models that has contributed to today's overreliance on standardized and theoretical valuation models within the financial community:[2]

> *For financial instruments that do not trade regularly, or that trade only in principal-to-principal markets, an entity should provide its best estimate of fair value. Judgments about the methods and assumptions to be used in various circumstances must be made by those who prepare and attest to an entity's financial statements. The following discussion provides some examples of how fair value might be estimated…*
>
> *Some financial instruments…may be "custom-tailored" and, thus, may not have a quoted market price. In those cases, an estimate of fair value might be based on the quoted market price of a similar financial instrument, adjusted as appropriate for the effects of the tailoring. Alternatively, the estimate might be based on the estimated current replacement cost of that instrument.*
>
> *Other financial instruments that are commonly "custom-tailored" include various types of options (for example, put and call options on stock, foreign currency, or interest rate contracts). A variety of option pricing models that have been developed in recent years (such as the Black-Scholes model and binomial models) are regularly used to value options.* ***The use of those pricing models to estimate fair value is appropriate under the requirements of this Statement****.*

The bolded sentence above provided the Financial Accounting Standards Board's (FASB's) approval for companies to apply Black-Scholes and binomial models to value financial instruments covered under the Statement. This endorsement was applicable to both the income approach and the market approach.

FAS 107's endorsement of Black-Scholes spanned from 1993 through 2007, during which time many companies took advantage of the FASB's wide approval of the valuation model by training internal staff to apply it in the valuation of many financial instruments, regardless of their level of liquidity. During this 15-year period, a culture of Black-Scholes acceptability permeated through preparers and auditors.

In 2007, FAS 107 was superseded by FAS 157, which was later codified into ASC 820. When an accounting rule is superseded, it generally means that the previous rules are null and void, and financial statement preparers are directed toward completely new rules. That is what happened with the guidance quoted above, FAS 107, Paragraphs 22 to 29 - they were deleted from U.S. GAAP literature.[3]

2 Old Paragraphs 22-29 of FAS 107, there is no corresponding reference in the Codification
3 This guidance did not survive in the Codification with a corresponding cross reference. This lack of cross reference can be seen in the FASB's codification cross reference tool, which skips from Paragraph 15 to Paragraph 31. The paragraphs in between are deleted, and have no surviving place in U.S. GAAP.

When FAS 157 emerged as the preeminent fair value accounting guidance, its purpose was to amend or replace all previously existing fair value accounting guidance. Companies are now subject to its provisions when applying a fair value methodology. FAS 157 did not endorse any particular valuation model or methodology, nor did it add to the population of financial instruments subject to fair value accounting. Rather, it provided a framework within which all valuations must fall.

Under ASC 820, the valuation methodology must properly consider all facts and circumstances that affect fair value and factor in all data that is available without undue cost and effort. As mentioned previously, it is an undisputed fact that Black-Scholes does not consider illiquidity. Furthermore, ASC 820 specifies the priority of each level of inputs. Observable inputs, such as illiquid securities prices, are always to be considered when available. Many companies are not aware that illiquid securities prices may be available through secondary trading activities, and that these prices are relevant to the valuation of similar securities.

To be in compliance with U.S. GAAP, it is critical to consider relevant price indications if they are available without undue cost and effort. That is the distinguishing feature of the approach illustrated in this white paper. The following excerpts from ASC 820 and FAS 157 help illustrate these points:

1. "The reporting entity shall not ignore information…that is reasonably available without undue cost and effort." (ASC 820-10-35)
2. "The reporting entity may use its own data to develop unobservable inputs, provided that there is no information reasonably available without undue cost and effort." (FAS 157 C85)
3. Valuation techniques used to measure fair value shall maximize the use of observable inputs and minimize the use of unobservable inputs (ASC 820-10-35-36, FAS 157 P21)

Most notably, ASC 820 (FAS 157) requires consideration of observable inputs that reflect illiquidity – inputs that standardized and theoretical models were never designed to consider.

The Black-Scholes model, developed in 1973, was never designed to include each element of today's accounting definition of fair value. Even before FAS 157 changed the way U.S. GAAP views the role of such models in valuation, Statement of Financial Accounting Concept No. 7, *Using Cash Flow Information and Present Value in Accounting Measurements* (SFAC 7), issued after FAS 107's endorsement of valuation models, discusses the limitations of the use of Black-Scholes in valuing liabilities. These discussions became a part of the FASB's studies that eventually led to the release of FAS 157. Here are some excerpts from paragraphs 107 and 54 of SFAC 7:

> *"Many modern pricing models, including the Black-Scholes model for pricing options, are built on replicating portfolios. However, the simple use of expected-earning rates to measure liabilities obscures both the investment risks inherent in the entity's assets and the uncertainties and risks inherent in the liabilities, which are different and unrelated risks…To the extent that a pricing model includes each of the elements of fair value, its use is consistent with this Statement."*

As discussed above, theoretical valuation models no longer carry a *carte blanche* endorsement by the FASB. More specifically, the Black-Scholes model is mentioned only once in ASC 825, as amended and interpreted, in the context of the income approach to valuation:[4]

> *Income approach. The income approach uses valuation techniques to convert future amounts (for example, cash flows or earnings) to a single present amount (discounted). The measurement is based on the value indicated by current market expectations about those future amounts. Those valuation techniques include present value techniques; option-pricing models, such as the Black-Scholes-Merton formula (a closed-form model) and a binomial model (a lattice model), which incorporate present value techniques; and the multiperiod excess earnings method, which is used to measure the fair value of certain intangible assets…*

While companies are still permitted to use Black-Scholes in certain situations involving the application of the income approach, users of financial statements need to be aware that its use is no longer permitted for the market approach. The need for this awareness was recently underscored by the SEC, which is investigating portfolio valuations by hedge funds. A market approach must now consider all information that is available without undue cost and effort; that is, all characteristics of the market within which the instrument, or comparable instruments, trade.

The long 15-year endorsement period helps explain why some companies continue to rely too heavily on Black-Scholes. Another key explanation is that many preparers and auditors are not aware that illiquidity discounts can be reliably estimated using secondary market data, such as prices of comparable illiquid securities. The main reason, however, is the need to better inform the financial community that Black-Scholes consistently overvalues illiquid options and warrants, and that other theoretical models, though customizable, fall short of providing a fair representation of illiquidity.

In a December 2010 speech, the SEC made public its concerns about relying on theoretical valuation models, especially in the case of warrants.[5] Warrants, and many other types of financial instruments, may contain features and provisions that are outside the capabilities of a theoreticalvaluation model. For example, warrants may contain down round protection or other provisions that can't be factored into a closed-form model. In a recent speech, SEC Chief Accountant Wayne Carnall concluded that some securities may be too complex for Black-Scholes. "Fair value may not be appropriately captured by simple models," he said.[6] The Black-Scholes model cannot account for special provisions found in many financial instruments, including anti-dilutive features, variable strike prices and market-based performance metrics.[7]

OPEN-FORM MODELS

While binomial lattice and Monte Carlo simulation models allow greater customization than the "closed form" Black-Scholes, they still ignore relevant observable data available from

4 ASC 820-10-35 (¶18b of FAS 157)
5 Treasury & Risk, April 1, 2011, Susan Kelly, SEC Frowns On Black Scholes
6 Treasure & Risk, April 1, 2011, SEC Frowns On Black Scholes
7 Valuation Strategies, March/April 2011, Black Scholes May No Longer Be An Option

secondary markets, as they exclude consideration of illiquid securities prices. The Pluris model discussed herein is based on empirical trading data from secondary markets. If the security in question is an equity of a Fortune 500 company, or if the valuation exercise involves stock compensation, open-form these models can be useful. But in the case of illiquid securities, or microcap stocks, observable trading data is critical to the valuation.

A BETTER MODEL

The missing element in all theoretical valuation models is the incorporation of empirical data. Such data is critical to achieving a valuation that reflects actual exit prices as of the measurement date, as required by accounting rules. Otherwise, a model provides little more than a theoretical possibility about where actual values might fall in a real transaction. To resolve this, Pluris created LiquiStat™, a database of private sales transactions. LiquiStat contains transactions facilitated by Second Market since April 2005.[8] Buyers and sellers tend to be hedge funds, institutions or accredited investors.

Data housed in LiquiStat is typically gathered from markets that are considered inactive for accounting purposes. An inactive market possesses one or more of the following characteristics:

- Few recent transactions (based on volume and level of activity in the market)
- Price quotations are not based on current information
- Price quotations vary substantially, either over time or among market makers
- Indexes that previously were highly correlated with the fair values of the asset are demonstrably uncorrelated with recent fair values
- Abnormal liquidity risk premiums or implied yields for quoted prices, when compared with reasonable estimates of credit and other nonperformance risk for the asset class
- Abnormally wide bid-ask spread or significant increases in the bid-ask spread
- Little information released publicly

Using data from LiquiStat in a valuation exercise requires significant judgment, because, while prices are allowed to arise from inactive markets, they cannot reflect distress. Pluris evaluates data it uses in its valuations to ensure there is no evidence of distress in a transaction. This is accomplished by studying the degree to which the market is deemed inactive, using the characteristics listed above, as well as whether there is evidence of sufficient time before the measurement date to allow for usual and customary market activities, and how many bidders there are for the asset. A model that uses empirical trading data is better than one that doesn't. Here is an example.

BLACK-SCHOLES CASE STUDY: XYZ COMPANY

The valuation of convertible securities is challenging because there must first be an allocation between the conversion option and the debt security to which the option is attached. In the following case study, we review the accounting implications of a pharmaceutical company relying solely on Black-Scholes to value the optionality component of a convertible security and demonstrate the direct impact this overreliance has on the company's compliance with U.S. GAAP.

8 Second Market is believed to be the largest trading platform for illiquid, alternative assets.

"The 'Optionality' portion of a convertible note reflects the holder's option to convert the note into a predetermined number of the issuer's common shares…"

The name of the company has been changed to XYZ Company, but this case study, which is presented from the issuer's perspective, is based on the following actual facts and circumstances:

- In August 2007, XYZ Company issued $100 million in 5.75% convertible debt, due August 2014
- The issuance generated net proceeds of $98.8 million
- The debt accrues interest at an annual rate of 5.75%, payable quarterly
- The conversion price is $10.88 per share

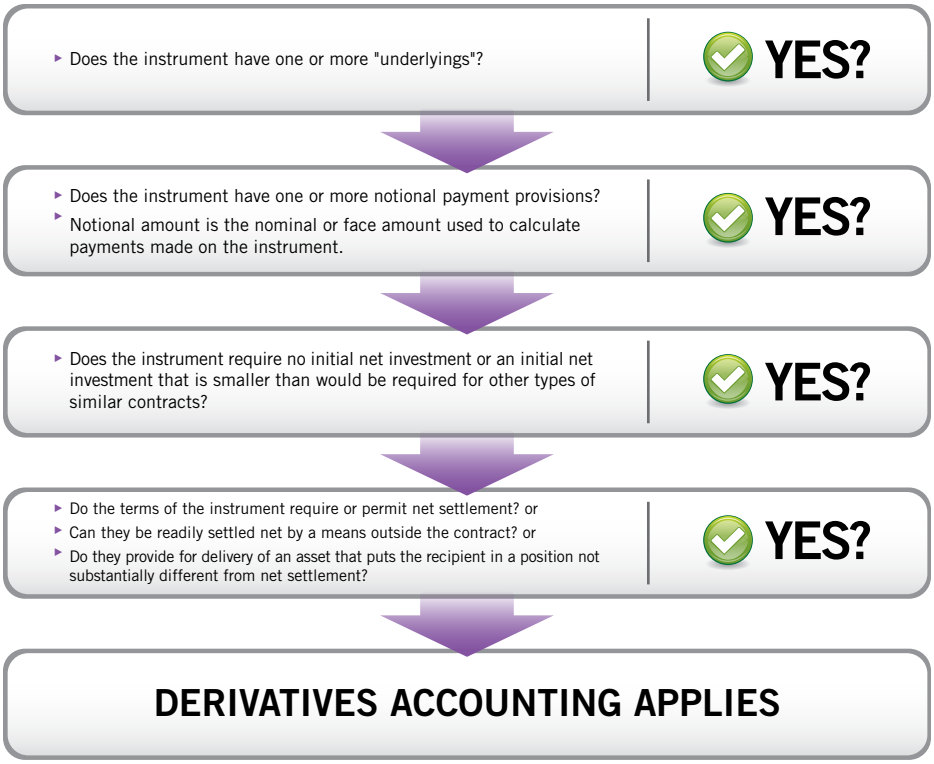
The following assumptions apply:

- The debt is subject to, among other rules, ASC 470, *Debt* (FASB Staff Position APB 14-1, *Accounting for Convertible Debt Instruments That May Be Settled in Cash upon Conversion (Including Partial Cash Settlement)*). As such, an allocation must be performed at the deal's inception. This is important because both the debt and the conversion option must be individually accounted for under separate accounting rules. For example, conversion features must be evaluated to determine whether derivatives accounting applies. Under derivatives accounting, the conversion option would be fair valued through the income statement.
- The debt has characteristics of debt (i.e., not equity) according to the provisions of, among other rules, ASC 480, *Distinguishing Liabilities From Equity (*formerly FAS 150*, Accounting for Certain Financial Instruments with Characteristics of Both Debt and Equity)*. As such, it is accounted for as debt and will not be subject to fair value accounting at inception. Under this assumption, fair value accounting would apply only if the debt is later modified in a manner that warranted fair value accounting, or if the company made an appropriate fair value election under ASC 825 (formerly FAS 159).
- At inception, the conversion option meets the conditions for equity classification according to the provisions of, among other rules, ASC 815-40 (formerly EITF Issue No. 00-19, *Accounting for Derivative Financial Instruments Indexed to, and Potentially Settled in, a Company's Own Stock* (EITF 00-19)). Under this assumption, derivatives accounting does not initially apply. This distinction is important, as equity classification treatment means that the conversion option needs to be fair valued only at inception (during the allocation process) and not on an ongoing basis.[9] If the conversion option were to be modified later in any way, it could lose treatment as an equity instrument.
- On January 1, 2008, assume the conversion option is modified later, so that equity classification treatment is lost. Such modifications often occur because an issuer's modification of a settlement provision triggers a change from equity classification to liability classification. This, in turn, causes the instrument to fall under derivatives accounting, which requires that the instrument be fair valued. Such modifications illustrate another danger of relying too heavily on Black-Scholes, since doing so may create undesirable volatility in the income statement. Under this assumption, the conversion option will be treated as a derivative measured at fair value, with periodic changes in fair value recorded in earnings starting from January 1, 2008.

9 ASC 470-20-05 (APB 14-1 paragraph 18)

The chart below summarizes the factors that need to be considered in determining whether derivatives accounting applies to the option component.[10]

HOW TO DETERMINE IF DERIVATIVES ACCOUNTING APPLIES:



THE ALLOCATION

At inception, fair value must be allocated between the debt and the conversion option, according to the provisions of APB 14-1, *(Accounting for Convertible Debt Instruments That May Be Settled in Cash upon Conversion (Including Partial Cash Settlement)*). The amount of fair value allocated to each component will become the respective initial carrying amount for accounting purposes. The fair value of the debt can be determined by comparing it to the fair value of a similar instrument that does not contain an equity conversion component. The fair value of the conversion option may then be determined by subtracting the fair value of the debt from the total proceeds of the convertible debt issuance.[11] Alternatively, the fair value of the conversion option could be determined first and then subtracted to yield the value of the fixed income debt, as further described in the section below.

10 ASC 815-10-15 (FAS 133, paragraph 6)
11 APB 14-1 paragraph 7, "The issuer of a convertible debt instrument…shall first determine the carrying amount of the liability component by measuring the fair value of a similar liability…that does not have an associated equity component. The issuer shall then determine the carrying amount of the equity component…by deducting the fair value of the liability component from the initial proceeds ascribed to the convertible debt instrument as a whole."

"The Black-Scholes pricing model ignores illiquidity and is therefore an inappropriate tool in valuing or bifurcating illiquid securities."

VALUATION METHODOLOGY

The main drivers for the valuation of convertible notes include the following:

- Terms (including anti-dilution protection, transferability restrictions, conversion price, maturity date, rights, preferences, privileges)
- Time until any restrictions are released
- Financial and other characteristics of the company
- Trading characteristics of the underlying security (exchange, volume, price and volatility)
- Precedent transactions

We have found that the most representative way to estimate the fair value of a convertible debt instrument is to bifurcate the instrument into its two components: an "optionality" portion that is appropriately discounted for liquidity and a "fixed income" portion.

OPTIONALITY PORTION

The optionality portion of a convertible note reflects the holder's option to convert the note into a predetermined number of the issuer's common shares at an agreed-upon conversion rate. We use a model that accounts for illiquidity and adjusts fair value accordingly. Our model determines an appropriate discount by evaluating actual discounts reflected by recent secondary market transactions. The source for this trading data is the LiquiStat database. Liquistat contains relevant and comparable data on trades in thousands of securities, including equities, warrants and convertible notes.

Our model calculates the Black-Scholes price at the time of the sale and compares it to the price at which the option would actually be sold in order to determine an appropriate discount. Since each discount arises from criteria specific to both the conversion option and the underlying stock, many factors must be considered in determining the discounts including the size, financial risk, growth and other factors concerning the issuer.[12]

The fair value of the optionality portion of the convertible note is determined by reducing the Black-Scholes value of the security by this discount.

12 For more data on the prices paid, and by extension discounts taken, for illiquid securities in the secondary markets, see, Robak (2007). "Discounts for Illiquid Shares and Warrants: The LiquiStat™ Database of Transactions on the Restricted Securities Trading Network." www.pluris.com/liquistat.html. Using statistics and regression analysis from empirical sale discounts, these factors include: (1) Delta from Black-Scholes, (2) Volatility of the underlying stock price, (3) Registration status of the underlying security, (4) Remaining time until expiration and (5) Total assets of the company. This Appendix is excerpted from Robak, Espen (2007). Discounts for Illiquid Shares and Warrants: The *LiquiStat™* Database of Transactions on the *Restricted Securities Trading Network*. www.pluris.com/liquistat.html

FIXED INCOME PORTION

The fixed income portion of the convertible note is then determined by utilizing the implied yield spread of the credit facility - both on the date it was issued and on the measurement date. In assessing an appropriate yield for the debt, an analysis of yield curves and relevant corporate credit spreads is conducted, and the fair value of the debt is determined using standard discounted cash flow techniques.

Finally, by combining the resulting values of the optionality and fixed income portions of the note, we are able to determine aggregate fair value for both the debt and the conversion option.

VALUATION EXAMPLE

Next, we illustrate the difference between an ASC 820 compliant valuation methodology outlined above and one that relies solely on Black-Scholes.

Presented below is a quarter-by-quarter analysis spanning from the date of issuance to the first quarter of 2010. Using Black-Scholes alone, the value of the conversion option widely fluctuates from $28.6 million to $74.8 million. However, these amounts take a dramatic drop once illiquidity is factored in, ranging from $14.2 million to $43.4 million.

Note the percentage differences in the following table. This table displays the estimated fair value of the conversion option using a Black-Scholes-only approach compared to the value of the same portion using our model, which takes into account a discount for illiquidity. When illiquidity is not considered, the option component is significantly overvalued – by up to 52 percent!

Measurement date	B-S only conversion option value ($)	LiquiStat-based value ($)	Difference ($)	% Difference
08/08/2007	35,249,052	17,659,852	17,589,470	50%
09/30/2007	54,966,374	31,179,832	23,786,542	43%
12/31/2007	39,162,668	18,767,186	20,395,482	52%
03/31/2008	38,047,632	18,480,680	19,566,952	51%
06/30/2008	43,493,680	22,713,346	20,780,334	48%
09/30/2008	74,718,830	43,340,926	31,377,904	42%
12/31/2008	59,044,854	35,072,788	23,972,066	41%
03/31/2009	41,284,222	22,148,640	19,135,582	46%
06/30/2009	50,029,202	27,239,700	22,789,502	46%
09/30/2009	38,788,478	19,796,134	18,992,344	49%
12/31/2009	28,568,524	14,154,354	14,414,170	50%
03/31/2010	40,893,658	23,914,634	16,979,024	42%

Since the issue date, when the fair values of the debt and equity components are first allocated, the difference between the Black-Scholes-only approach and the approach outlined herein that adjusts for illiquidity are clearly material, relative to the numbers presented:

Black-Scholes-only	
Proceeds	$98.4 million (100%)
Fair value of fixed income portion	$64.8 million (65.9%)
Fair value of conversion portion	$33.6 million (34.1%)

Valuation adjusting for illiquidity	
Proceeds	$98.4 million (100%)
Fair value of fixed income portion	$82.3 million (83.6%)
Fair value of conversion portion	$16.1 million (16.4%)

If the numbers above under a Black-Scholes-only approach aren't misleading enough, imagine adding a material misstatement in the income statement. As noted previously, illiquid derivatives such as conversion options are often modified down the road. These modifications can alter the accounting treatment, causing the conversion feature to be subject to fair value accounting provisions.

In our example, such a modification occurred on January 1, 2008. Below is a snapshot of the impact on earnings. There is a material misstatement on the income statement when the Black-Scholes-only model is applied:

Black-Scholes-only	
Earnings FYE 12/31/08:	$31.7 million
Difference	$3.3 million
As a percentage of 12/31/08 earnings:	10.4%

SUMMARY

The Black-Scholes model is no longer endorsed, as it was before FAS 157 was released, nor did it survive FAS 157's codification into ASC 820. In addition, the relevant secondary market trading data indicates the model overvalues illiquid securities – sometimes by multiples over fair value. To develop an estimated fair value in compliance with U.S. GAAP, illiquidity must be taken into consideration.

In almost every private deal, illiquidity will be a factor, due to the lack of active trading of the securities issued. Using a Black-Scholes only approach will distort allocation of fair value and earnings by potentially overvaluing the conversion option. The Black-Scholes pricing model ignores illiquidity and is therefore an inappropriate tool in valuing or bifurcating illiquid securities.

Other theoretical models, such as the binomial lattice and Monte Carlo simulation models, are also no substitute for using market-based data to value illiquid assets. In addition, when market-based pricing information is readily available, valuations based solely on these theoretical models are no longer compliant with U.S. GAAP.

Auditors and regulators are increasingly taking a closer look at how companies account for the "optionality" value under FAS 157, and we expect this scrutiny to increase going forward.

If you or your clients are concerned about the implications of FAS 157 (as codified in ASC 820) on convertible debt, we invite you to contact us at 212.248.4500 or info@pluris.com.

APPENDIX I: EXPLANATION OF VARIOUS VALUATION METHODOLOGIES[13]

Depending on the type of option and its payoff characteristics, several theoretical models are used to value traded or otherwise fully-liquid instruments. The standard model for a European-style call option on common stock is the Black-Scholes formula. The Black-Scholes formula was introduced in 1973 by Fischer Black and Myron Scholes[14] as a pricing model for options and warrants:

$$c = SN(d_1) - Ke^{-rT}N(d_2), \text{ where}$$

$$d_1 = \frac{\ln(S/K) + (r + \sigma^2/2)T}{\sigma\sqrt{T}}, \text{ and } S$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

S = the price of the stock
K = the strike price of the option
$N(x)$ = standard normal cumulative distribution
σ = the volatility of the stock
r = the risk-free rate of return
T = time to maturity

The model is based on the following assumptions:[15]

1. The stock price follows a constant Brownian motion (with μ and σ constant).
2. Short selling with full use of proceeds is permitted.
3. There are no transactions costs or taxes and all securities are perfectly divisible.
4. There are no dividends during the life of the option or warrant.
5. There are no riskless arbitrage opportunities.
6. Security trading is continuous for both the option and the stock.
7. The risk-free rate of return is constant and the same for all maturities.

None of these assumptions hold perfectly in real-world situations; however, for fully-liquid stock options on actively traded stocks, the assumptions hold well enough to have permitted the Black-Scholes option model to become ubiquitous in use among options traders. Known biases in the model ("volatility smiles," for example) for actively traded options are typically very minor and can be handled automatically by trading software. With non-tradable options and warrants, however, the discounts from the model price can be expected to be quite significant.

13 This Appendix is excerpted from Robak, Espen (2007). Discounts for Illiquid Shares and Warrants: The *LiquiStat™* Database of Transactions on the *Restricted Securities Trading Network*. www.pluris.com/liquistat.html
14 Black, Fischer and Myron S. Scholes (1973). The pricing of options and corporate liabilities, *Journal of Political Economy*, 81 (3), 637-654.
15 Hull, J. (2006) Options, Futures, and Other Derivatives, 6th ed. Pearson Prentice Hall. pp 290-291.

Option Valuation Concepts

A few more concepts and terms typically found in option and warrant contracts are introduced here for clarification:

EUROPEAN, AMERICAN, AND ASIAN OPTIONS

European-style options are exercisable only at the end of the option period, while American options are exercisable at any time during the life of the option. An Asian option is exercisable at the end, but derives its payoff from the average price of the stock during the option period, rather than from the price at the exercise date. A Lookback option's payoff is derived from the maximum (or sometimes minimum) stock price during the life of the contract.

INTRINSIC VALUE AND "MONEYNESS"

In-the-money options have positive intrinsic value, meaning they would yield a profit if exercised (i.e., the stock price is greater than the strike price). An option's value over and above its intrinsic value is called its "time value" (or, because most options have positive time values, its "option premium" or "time premium"). The "moneyness" of an option can be defined as the fraction of its stock price over its strike price (S/K). In practical analysis, since S/K is not a particularly "well behaved" variable, ln(S/K) can be used instead.

DELTA

An option's delta is the relationship between the option value and the stock price. It is defined as $N(d_1)$ in the Black-Scholes formula (see above) for the standard call option.

CASHLESS EXERCISE

This feature, quite common in both option and warrant contracts, allows the holder to exercise the warrant without paying any cash. The warrant or option is net-settled with stock equal to the total intrinsic value of the warrant or option at exercise. Cashless exercise may also be granted subject to certain conditions, for example a time limit or only after certain criteria are met.

CALL-CAPS AND BARRIER OPTIONS

Warrant contracts also often have limitations on their exercise. A typical call-cap provision would allow the issuer to redeem the warrant (i.e., force exercise) if the stock price has exceeded 200 percent of the strike price for more than 20 consecutive trading days. Such provisions closely mirror those typical of Barrier options and warrants with call-caps can be valued with standard Barrier option models.

OTHER COMMON TERMS

Other terms typically seen in option and warrant contracts include anti-dilution provisions, ownership limitations, authorized share failure redemption rights, listing failure redemption rights, change of control rights, registration rights, and transfer restrictions.

Illiquidity and Exercise Behavior

Thus far, most of the work published on illiquid options and warrants focuses on the behavior of holders of illiquid stock options (mostly, employee stock options). The conclusions from these studies were important in framing the debate over SFAS 123 and its revised version.

Kulatilaka and Marcus note that a holder who wants to reduce his option position would sell

part of the position.[16] "Because employee stock options are not transferable, however, the only way to cash them in is to exercise them […]" Such early exercise reduces the market value of the options. Kulatilaka and Marcus derive an early exercise model, where early exercise is driven by the need for diversification. Their results imply that historical exercise patterns, since they are driven by past stock price performance, are a poor guide for future exercise patterns. Their results further imply that – although the value of traded options always increases with volatility – depending on the level of investor risk aversion, the value of illiquid options may sometimes decrease with increasing volatility (because higher volatility at some point leads to earlier exercise). The latter implication is empirically supported for non-traded warrants by the data in the LiquiStat database.

Hall and Murphy show that executives demand large premiums for accepting stock options in lieu of cash compensation because options are worth less to executives than they cost to the issuing firm.[17] Applying a certainty-equivalent approach, they find that the Black-Scholes model always overvalues non-traded stock options, that far in-the-money executive options are routinely exercised at vesting or fairly shortly thereafter because the expected utility from locking in their gains exceed the utility from holding the options. Their model indicates that executives with low levels of risk aversion and a high concentration of wealth tied up in the company's equity assign values to stock options between 25 and 70 percent of the Black-Scholes value. In fact, in this model, values are in some circumstances assigned below intrinsic value (which in and of itself would tend to explain early exercise behavior). Carpenter also holds that the value to executives of their options can be different from their cost to shareholders.[18] However, her model does not require estimates of wealth concentration or risk aversion, which are unobservable. Based on a sample of 40 executive option grants, Carpenter finds an average *actual* time to exercise of 5.8 years (as opposed to total allowed time to exercise of 10 years).

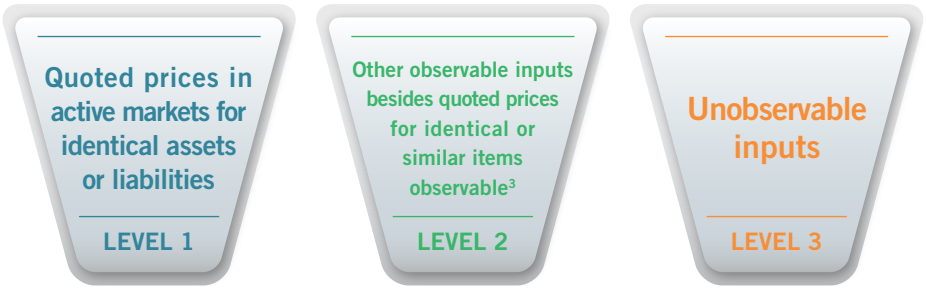
Finnerty shows that the FASB's chosen method of shortening the time to exercise cannot fully account for the lack of liquidity for employee stock options and will therefore tend to overstate their fair market values.[19] Finnerty's model solves the problem of how to use historical early-exercise data from an issuer to estimate future early-exercise patterns. One cannot just extrapolate from the past as past exercise behavior has been driven by stock price patterns which may not be repeated. Finnerty notes that since options are leveraged investments, the "impact of any transfer restrictions will be magnified, and the discount for lack of marketability should be greater" for options than for restricted stock – which is supported by the data in LiquiStat. Overall, Finnerty finds that employee stock options, at grant, are worth approximately half their Black-Scholes values.

16 Kulatilaka and Marcus (1994) "Valuing Employee Stock Options" Financial Analysts Journal 50 (Nov/Dec) p. 46-56.
17 Hall and Murphy (2002) "Stock Options for Undiversified Executives" Journal of Accounting and Economics 33 (Feb) p. 3-42.
18 Carpenter (1998) "The Exercise and Valuation of Executive Stock Options" Journal of Finance 52 (Mar) p. 127-158
19 Finnerty (2005) "Extending the Black-Scholes-Merton Model to Value Employee Stock Options" Fordham University working paper, January 2005.

APPENDIX II: HOW FAS 157 BUCKETING WORKS

FAS 157 defines fair value quite differently than its predecessor, FAS 107. Under FAS 157, fair value is defined as "the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction."[20] On the other hand, FAS 107 defines fair value as "the amount at which the instrument could be exchanged in a current transaction between willing parties, other than in a forced or liquidation sale."[21] In addition to the definition of fair value being worded slightly different, FAS 157 introduced the concept of exit price, highest and best use, and most advantageous market.

FAS 157 requires fair value measurements be bucketed into one of three levels within a predefined hierarchy, based on the quality of in the inputs available to market participants:



"Bucketing" depends on many factors, including:

- The observability of market prices
- The availability of observable market prices
- The extent to which the market generating those prices is "active"
- Whether the securities underlying those prices are identical or similar to the reference security
- Whether the price reflects a distressed transaction

The three hierarchies are primarily distinguished by the observability of input data. The level within the fair value hierarchy that is used to report security values must reflect the most observable information available. It is this requirement that leads to the classification of most PIPE securities as Level 2 or 3 securities, as the best information available is often observable prices in inactive markets.

Level 2 inputs include the following:

- Quoted prices for *similar* assets or liabilities in *active* markets
- Quoted prices for identical *or* similar assets or liabilities in markets that are *not active*
- Observable inputs other than quoted prices
- Inputs that are supported by observable market data (market-corroborated inputs)

20 FASB ASC 820-10-35
21 FASB 107-5

A market considered not active is generally one in which:

- There are few transactions
- Prices are stale
- Prices vary too widely over time or between market makers
- Extraordinarily wide bid-ask spreads

Examples of observable inputs other than quoted prices would include:

- Interest rates
- Yield curves
- Volatilities
- Prepayment speeds
- Loss severities
- Credit risks
- Default rates

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Espen Robak is President and founder of Pluris Valuation Advisors LLC and a nationally recognized expert on intellectual property and business valuation, restricted and illiquid securities, securities design, levels of value, and discounts for lack of liquidity. Pluris' practice includes portfolio valuations for investment funds and financial institutions, as well as a broad range of financial reporting and tax opinions for public and private companies. Mr. Robak is a frequent contributor to books and professional journals on valuation, accounting and taxation topics. He is a columnist for Wealth Strategies Journal. Mr. Robak has earned the Chartered Financial Analyst designation and has a Masters in Business Administration and a Bachelor of Sciences degree from the University of Oregon.

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