The Inadequacy of Disclosure Regarding Employee Stock Options

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Abstract

The academic community has long recognized the fact that granting stock options to employees is a significant economic event that affects shareholder value, and has long asserted that companies should be required to report the impact of option grants on their financial statements. Partially in response to such criticism, the Financial Accounting Standards Board (FASB) amended the Statement of Financial Accounting Standards 123 (*Accounting for Stock-Based Compensation*) to require that companies must report employee stock option grants as an expense. However, as shown in this paper, investors still lack adequate disclosure regarding employee stock options.

When viewed from the perspective of corporate valuation models, investors seeking to estimate the fundamental market value of equity need information sufficient for them to estimate the values of all claims held by others than the current equity holders. Because option grants are one such claim, investors need sufficient information to estimate the current value of option grants. Companies presently report only summary statistics for groups of options, with a group often containing options with significantly different exercise prices and remaining times until expiration. Such heterogeneous grouping can lead to significant errors in valuation. To remedy this problem, investors need the exercise prices and effective times until exercise for all option grants, rather than the summary statistics now being reported. If a company has too many outstanding option grants to make this practical, then the company should report summary statistics for groups that are much more homogeneous with respect to both exercise price and remaining time until expiration than are currently being reported.

I. Introduction

The academic community has long recognized the fact that granting stock options to employees is a significant economic event that affects shareholder value, and has long asserted that companies should be required to report the impact of option grants on their financial statements. Partially in response to such criticism, the Financial Accounting Standards Board (FASB) amended the Statement of Financial Accounting Standards 123 (*Accounting for Stock-Based Compensation*) to require that companies now must report employee stock option grants as an expense. However, the amended SFAS 123 still fails to provide disclosure that adequately satisfies the primary objectives of financial reporting as stated by the Securities and Exchange Commission or the Financial Accounting Standards Board.

The Securities and Exchange Commission (SEC) has the legal authority to establish and enforce accounting standards for U.S. publicly traded firms. The SEC's mission statement declares, "The primary mission of the U.S. Securities and Exchange Commission (SEC) is to protect investors and maintain the integrity of the securities markets. … To achieve this, the SEC requires public companies to disclose meaningful financial and other information to the public, which provides a common pool of knowledge for all *investors to use to judge for themselves if a company's securities are a good investment*."[1] Judging whether a company's common stock is a good investment requires that a potential investor be able to estimate the fundamental value of the stock. If the fundamental value of the stock is less than the current market price, then the stock is not a "good investment." Conversely, if the fundamental value is greater than the stock price, then the stock might be a "good investment." In other words, actualization of the SEC's mission statement requires that financial reporting should aid investors in estimating the fundamental value of equity.

In practice, the SEC delegates much policymaking to the Financial Accounting Standards Board (FASB). FASB states that its mission is "to establish and improve standards of financial accounting and reporting for the guidance and education of the public, including issuers, auditors and users of financial information. Accounting standards are essential to the efficient functioning of the economy because *decisions about the allocation of resources rely heavily on credible, concise, transparent and understandable financial information.*"[2]

[1] See http://www.sec.gov/about/whatwedo.shtml. Italic highlights are added here for emphasis.
[2] See http://www.fasb.org/facts/index.shtml. Italic highlights are added here for emphasis.

FASB's Statement of Financial Accounting Concepts No. 1 (Objectives of Financial Reporting by Business Enterprises) echoes this sentiment. In its section "Objectives of Financial Reporting," the three sub-sections are titled "Information Useful in Investment and Credit Decisions," "Information Useful in Assessing Cash Flow Prospects," and "Information about Enterprise Resources, Claims to Those Resources, and Changes in Them." In particular, paragraph 34 states that "Financial reporting should provide *information that is useful to present and potential investors*".[3] Paragraph 40 states that "Financial reporting should provide information about the economic resources of an enterprise" and **"***the claims to those resources* (obligation of the enterprise to transfer resources to other entities)**".**[4]

As noted in the quotes above, FASB's mission and objectives clearly highlight the importance of helping investors evaluate a company's securities as potential investments. FASB specifically mentions the use of financial reporting by investors to evaluate "claims." While "claims" often mean "liabilities," this is not a sufficiently broad definition from the perspective of current or potential equity investors. From their perspectives, the relevant claims are all claims held by any group other than themselves, and this specifically includes the claims held by option grantees. This is a critical point that is not adequately addressed by current employee stock options disclosures requirements. As shown later in this paper, current disclosure requirements do not provide investors the necessary information to adequately estimate the value of claims held by option grantees.

The remainder of the paper is organized as follows. Section II describes the valuation process and information required by potential equity investors, including the need to evaluate claims by others than the current equity holders. Section III provides a numerical example illustrating the magnitude of potential errors in valuing outstanding employee stock options when the analysis is based upon the data that are presently required to be disclosed. Section IV provides a numerical example illustrating the estimation of a stock's fundamental value when

[3] Italic is added here for emphasis.

[4] Italic is added here for emphasis. Similar objectives are espoused by the International Accounting Standards Board (IASB); see http://www.iasc.org.uk. The IASB states that its mission is "committed to developing, in the public interest, a single set of high quality, understandable and enforceable global accounting standards that require transparent and comparable information in general purpose financial statements." The IASB goes on to state, "in the absence of regulation, financial reporting may not give the *information that users need to make informed assessments of companies*. Accounting standards aim to promote comparability, consistency and transparency, in the interests of users of financial statements. Good financial reporting not only *promotes healthy financial markets, it also helps to reduce the cost of capital* because investors can have faith in companies' reports." Italics have been added for emphasis.

there are employee stock options. As the example shows, significant errors in the estimated fundamental stock value can occur when using the stock option data that are presently required to be disclosed. Section V is a brief summary.

II. The Fundamental Value of Equity: Entity Valuation Models and Employee Stock Option Grants

Although there are many ways to estimate fundamental stock values, a survey by the Manufacturers Alliance indicates that corporate practitioners consider entity valuation models to be the most important methods for estimating the value of a potential acquisition.[5] The academic literature, practitioner literature, and textbooks also espouse entity valuation models, particularly those based upon discounted cash flows.[6] Following is a brief description of the entity valuation process, which highlights the importance of estimating the value of option grantees' claims.

Entity valuation models require that investors first estimate the total value of a company. By definition, a company's total value is equal to the value of its nonoperating assets plus the value of its operating assets, where V_T denotes the total value, V_{Non} denotes the value of nonoperating assets, and V_{Op} denotes the value of operating assets:

$$V_T = V_{Non} + V_{Op} \tag{1}$$

The values of most nonoperating assets, such as Treasury bills, can be determined directly by prices reported in the marketplace. In contrast, the value of operations must be estimated by investors. Let FCF_t denote the expected free cash flow at year t and WACC denote the weighted average cost of capital.[7] The value of operations can be estimated as the present

[5] Meckstroth (1998) reports that a survey by the Manufacturers Alliance indicated that corporate practitioners consider the discounted cash flow approach to be the most important method for estimating the value of a potential acquisition. EBITDA multiples were considered to be the second most important method.

[6] For example, see Kaplan and Ruback (1995), Copeland, Koller, and Murrin (2000), or Brigham and Ehrhardt (2005).

[7] Free cash flows are defined as net operating profits after taxes minus the company's net investment in operating capital. See Copeland, Koller, and Murrin (2000) or Daves, Ehrhardt, and Shrieves (2005) for more details on calculating free cash flow.

value of the free cash flows when discounted at the weighted average cost of capital: [8]

$$V_{Op} = \sum_{t=1}^{\infty} \frac{FCF_t}{(1 + WACC)^t} \quad (2)$$

Given estimates of the value of nonoperating assets, the value of operations, and the total value of the firm, the next step in entity valuation approaches is to estimate the fundamental value of common equity (denoted by E) by subtracting the estimated market values of non-equity claims from the total value of the company. These claims typically include debt and preferred stock (denoted by D and PS, respectively). Many companies also have relatively large amounts of outstanding option grants, and the value of these grants (denoted by W, since option grants are warrants in sheep's clothing) should also be subtracted from the total entity value when estimating the fundamental value of equity:

$$E = V_T - D - PS - W \quad (3)$$

Let n denote the number of outstanding shares. The estimate of the fundamental stock price, P_f, is: [9]

$$P_f = E / n. \quad (4)$$

Equation (3) exposes a serious deficiency in the current disclosure requirements regarding employee stock options: investors need sufficient information to estimate the value of option grants at the time the investor is estimating the fundamental stock price. However, companies are now required only to report the option grants' estimated market values at the time of the grant of the valuation. At dates subsequent to the grant, companies are only required to disclose in their footnotes summary information for groups of outstanding option grants, such as the group's average exercise price and the group's average remaining time until expiration. This summary information is insufficient for two reasons.

[8] There are many approaches to entity valuation, such as entity multiplier models (e.g., EBITDA multipliers and sales multipliers). This discussion focuses upon the discounted cash flow approach because it has been shown to be accurate (see Kaplan and Ruback (1995) and Copeland, Koller, and Murrin (2000)) and because it is based upon fundamental economic principles. It should also be noted that if a firm's capital structure includes convertible securities (including employee stock options), the component costs of capital, such as the cost of equity, will vary over time as total firm value, stock price, and remaining time until expiration of the convertible securities vary. Even thought the component costs might vary over time, the presence of convertible securities will not cause the overall WACC to vary over time; see Daves and Ehrhardt (2004) for more discussion of this issue.

[9] If the fundamental stock price is not equal to the observed market price, then W and E must be estimated jointly; see Bensoussan, Crouhy, and Galai (1995), Galai and Schneller (1978), and Crouhy and Galai (1991). The numerical example in Section IV illustrates this process.

First, option values are nonlinear with respect to their valuation model inputs, so the use of the reported summary statistics as inputs (such as the group's average exercise price, which is a linear transformation of the individual exercise prices) will produce biased estimates of option value.

Second there are other company-specific factors that affect the value of outstanding grants. For example, some employees will forfeit underwater options by leaving the company after the options vest but before they expire, and most employees actually will exercise their options prior to the expiration date.[10] Thus, the reported remaining time until expiration actually overstates the "effective" time to expiration. Although SFAS 123 requires companies to incorporate the effective remaining time until expiration when they value the option at its grant date, companies are not required to report their estimate of the effective remaining time until expiration, either at the grant date or at subsequent reporting dates.

Sections III and IV provide numerical examples illustrating the errors in valuation that can occur due to these two problems. The example in Section III shows that even if the fundamental stock price is equal to the market price, the estimated option values will be biased. The example in Section IV shows that if the investor is trying to estimate the fundamental value of equity, then the current disclosure requirements lead to biased estimates of the fundamental stock price and the options.

It is important to note that the inadequacy of reporting requirements for stock option grants is in contrast to disclosure requirements for debt and preferred stock. Footnotes disclose sufficient information regarding debt and preferred stock so that an investor is able to estimate with reasonable accuracy the values of these claims. In addition, there are a variety of public sources of information regarding the details of debt and preferred stock issues. In fact, often it is possible to obtain directly market prices for many debt and preferred stock issues. For option grants, however, the company's disclosure is the investors' only source of information, which means it is especially important for companies to disclosure sufficient information for investors to accurately estimate the value of option grants.

[10] For a discussion of these and other aspects of valuing employee stock options, see Rubinstein (1995). For an empirical analysis of exercise patterns, see Huddart and Lang (1996).

III. Estimating Employee Stock Option Values Based upon Current Disclosure Requirements: A Numerical Example

As noted in Section II, the nonlinearity of option pricing models and the differences between the contractual time until expiration and the effective time until expiration can cause significant errors when estimating option values. The following numerical example illustrates the potential magnitudes of these errors.

With respect to the issue of nonlinearity, consider the following simple numerical illustration. Suppose a company has two tranches of outstanding option grants, where a tranche is defined as a group of identical options, i.e., those with the identical exercise prices and expiration dates. The first tranche has 322 million options, each with an exercise price of $25 and a remaining life of one year. The second has 322 million options, each with an exercise price of $13 and a remaining life of 9 years. Rather than report each tranche separately, companies typically report summary statistics for groups of options, showing the weighted average of the exercise price and remaining life.

For example, Table 1 reports this information from the Coca-Cola Company's 10-K report for the fiscal year ending December 31, 2004. Notice that each grouping is for options with a relatively wide range of exercise prices. The range of exercise prices is $10 for the first three groupings and $26.75 ($86.75 minus $60.01) for the fourth group. Coca-Cola reports the weighted average time remaining until the contractual expiration of the option, with the weights determined by the number of contracts with the same exercise price. Coca-Cola also reports the weighted average exercise price for each grouping. Thus, each group can be composed of options that are relatively heterogeneous with respect to both time to expiration and exercise price.

Table 1: The Reported Summary Statistics for the Coca-Cola Company's Options (December 31, 2004; shares in millions)

	Outstanding Stock Options			Exercisable Stock Options	
Range of Exercise Prices	Shares	Weighted-Average Remaining Contractual Life	Weighted-Average Exercise Price	Shares	Weighted-Average Exercise Price
$30.00 to $40.00	6	0.8 years	$35.63	6	$35.63
$40.01 to $50.00	119	10.3 years	$46.03	53	$47.57
$50.01 to $60.00	48	9.1 years	$56.25	47	$56.30
$60.01 to $86.75	10	3.8 years	$65.85	10	$65.85
$30.00 to $86.75	183	9.3 years	$49.41	116	$52.02

Source: Footnote 13 from the Coca-Cola Company's 10-K report for the fiscal year ending December 31, 2004

Returning to the original example, suppose that the company in the example doesn't report data for each of its tranches separately, but instead puts the two tranches into a single group and reports only the weighted average values for the grouping. In particular, the company reports that it has 644 million outstanding options with a range of exercise prices from $13 to $27, a weighted average exercise price of $20, and a weighted average remaining life of 5 years. The company has 4,000 million outstanding shares of common stock. In this example, it is assumed that the observable market stock price of $20 per share is equal to the fundamental stock price; Section IV shows a more comprehensive example in which an investor begins with an estimate of the total value of the company and then estimates both the fundamental stock price and option value.

Hull's (2003; p. 253-255) warrant pricing formula, modified to incorporate a continuous dividend yield, is used to estimate the value of the options in the combined tranche based upon the summary statistics reported by the company. The model is then used to determine true value of the options, which is the value that an investor would estimate for each individual tranche if the investor had tranche-specific information rather than only the summary statistics. The following application of Hull's model shows how much error there can be when an investor has access only to the summary statistics and not the individual tranche's data.

Let P_o denote the observed stock price. For this illustration, assume that the stock is fairly priced: the market price (P_o) is equal to the fundamental price (P_f); this assumption is relaxed in the next section. Let q denote the continuous dividend yield (assumed to be 1% in this

example). Let r_{RF} denote the risk-free interest rate for the appropriate term. Using yields from a recent term structure, r_{RF} is 1.41% for a one-year term, 3.17% for a five-year term, and 4.01% for a nine-year term. Let T denote the time to expiration and X denote the expiration price. Let Q, the total value of quasi-equity, be defined as:

$$\begin{aligned} Q &= V_T - D - PS \\ &= E + W . \end{aligned} \tag{5}$$

Q is the total value of the equity and options, and it is the underlying asset. It is assumed that dQ follows a Gauss-Wiener process, with σ denoting the instantaneous standard deviation of dQ/Q. For this example, σ is 0.427. Let ω denote the value of a single option and m denote the number of options; each option entitles its owner to purchase a single share of stock. Let the adjusted stock price, P*, be defined as:

$$P^* = P_o\, e^{-q\,T} + m\omega/n . \tag{6}$$

The estimated value of the warrant is the solution to the implicit function involving the Black-Scholes option pricing formula:

$$\omega = [n/(n+m)]\ \mathrm{BSOPM}(P^*, X, \sigma, T, r_{RF}) \tag{7}$$

where

$$\mathrm{BSOPM}(P^*, X, \sigma, T, r_{RF}) = P^* N(d_1^*) - X e^{-r_{RF} T} N(d_2^*) , \tag{8}$$

$$d_1^* = \frac{\ln(P^*/X) + (r_{RF} + \sigma^2/2)T}{\sigma\ \sqrt{T}} , \tag{9}$$

$$d_2^* = d_1^* - \sigma\, T^{1/2} , \tag{10}$$

and $N(\cdot)$ is the cumulative normal distribution function.[11]

Using the summary values reported by the company, an investor would calculate the value of the reported options as $7.279 each, for a total of $4,687 million. However, this differs substantially from the value that the investor would estimate if the investor were shown the exercise price and remaining time until expiration for each individual tranche, rather than the summary statistics. Using the same warrant pricing model but substituting the actual exercise price and time until expiration, the options in the first tranche are worth $1.232 per option, while

[11] Notice that the solution involves an implicit function, because the adjusted stock price in Equation (6) is a function of the option price, but the option price in Equation (7) is itself a function of the adjusted stock price. Fortunately, this is quite simple to solve using the iteration feature in Excel.

those in the second tranche are worth $11.752. The combined value of the two tranches is $4,210 million. This example shows that the summary information reported in the footnotes would lead an investor to incorrectly estimate the total value as $4,687 million, which is about 11.3% higher than the correct value that would be estimated if the individual exercise prices and times until expiration were reported.[12]

Table 2 reports the pricing errors for a range of stock prices, under the assumption that the fundamental price is equal to the observed market price; this assumption is relaxed in the next section. Column A shows the pricing errors for the parameters used in the example above. Notice that the errors are large for a many different levels of stock prices relative to the exercise prices. As stock prices get large, the pricing errors converge to zero, although not very fast. For the two tranches in Column A, the first tranche is worth very little because it has a short remaining time until exercise (1 year) and a relatively high exercise price. Column B reverses the remaining times until exercise of the two tranches. Again, the errors are often large, showing that the errors in Column A are not simply due to the relatively small value of the first tranche in Column A. Column C sets the remaining times until exercise for both tranches to five years, the same as the reported weighted average time until exercise for the combined group; the errors are still large.

Column D sets the exercise prices of the two tranches equal to the reported $20 exercise price of the combined tranches. The errors are still very large. This demonstrates that even grouping options with very similar exercise prices will not prevent large estimation errors if there are disparities in the remaining times until expiration.

[12] Notice that there is also a simultaneity issue involved in the estimation of the two tranches in the sense that the value of one tranche affects the value of the other tranche. In other words, the values of the two tranches and the value of equity should be determined simultaneously. Dennis and Rendleman (2004) provide a binomial approach for estimating warrant prices simultaneously, an approach that takes into account the path dependence of this problem (i.e., the value of a warrant with a long time until expiration depends upon whether an option with a shorter time to expiration is exercised). They show that this type of "simultaneity" has a relatively small impact on warrant prices if the warrants comprise a relatively small proportion of the firm's capital structure. Ignoring this aspect of simultaneity in Equations (6)-(10) causes the calculated option prices to be slightly too high. Thus, the option prices of the two tranches calculated in the illustration are actually slightly biased upward, which means that the true error from using the summary statistics for the "single" tranche is actually slightly larger than shown.

Table 2: The Impact of Nonlinearity on Estimated Stock Option Values.

The table shows the percentage errors in estimated option values when option values are calculated as a single combined tranche instead of correctly calculated separately as the two individual tranches. The percentage errors are based on the total value of all outstanding options, not on the price per individual option. For all columns, the standard deviation of the underlying asset is 0.427 and there are 322 options per tranche. The fundamental stock price is assumed to equal the observed stock price in all cases. Differences in exercise prices, maturity, and the risk free rate are shown for each tranche for each column.

	Column A		Column B		Column C		Column D	
Tranche:	1	2	1	2	1	2	1	2
Exercise Price:	$27	$13	$27	$13	$27	$13	$20	$20
Time Until Expiration (years):	1	9	9	1	5	5	1	9
Risk free rate:	1.41%	4.01%	4.01%	1.41%	3.17%	3.17%	1.41%	4.01%

Stock Price	% Error	% Error	% Error	% Error
$2.00	-85.5%	-61.2%	-42.5%	-74.8%
$4.00	-65.2%	-26.0%	-30.7%	-47.0%
$6.00	-47.4%	-4.8%	-24.0%	-25.3%
$8.00	-32.2%	3.4%	-19.5%	-8.9%
$10.00	-19.5%	3.5%	-16.2%	2.4%
$12.00	-9.2%	0.7%	-13.7%	9.3%
$14.00	-1.2%	-2.4%	-11.7%	12.5%
$16.00	4.8%	-5.0%	-10.0%	13.3%
$18.00	8.8%	-6.8%	-8.7%	12.7%
$20.00	11.3%	-8.0%	-7.7%	11.3%
$22.00	12.7%	-8.7%	-6.7%	9.7%
$24.00	13.2%	-9.1%	-6.0%	8.1%
$26.00	13.0%	-9.2%	-5.3%	6.6%
$28.00	12.6%	-9.2%	-4.8%	5.3%
$30.00	11.8%	-9.1%	-4.3%	4.2%
$32.00	11.0%	-8.9%	-3.9%	3.2%
$34.00	10.2%	-8.6%	-3.6%	2.4%
$36.00	9.3%	-8.3%	-3.2%	1.8%
$38.00	8.5%	-8.1%	-3.0%	1.2%
$40.00	7.7%	-7.8%	-2.7%	0.8%

As Table 2 indicates, investors need the actual exercise price and remaining time until expiration for each individual tranche rather than summary statistics for a combined group. For a company with hundreds of option tranches, it might be quite onerous to provide this information about each tranche. However, the company should at least be required to provide much more heterogeneous groupings based upon both exercise price and time until expiration. For example, option grants could be grouped so that options within a group have exercises prices that differ by at most $4 and have remaining times until expiration that differ by at most two years. Most option grants are typically granted with original times until expiration of ten years or less, which would lead to at most 5 classifications based on the remaining time until expiration. Most stocks trade for less than $100 per share, so the there would be at most 25 classifications based upon exercise price. This would result in at most 125 groups, but it is likely that a typical company would have to report far fewer groups because many of the possible 125 groups would have no outstanding option grants with that particular combination of exercise price and remaining time until expiration.

For the example in Table 2, the total value of the options is about 5% of the total value of the combined options and equity. Interestingly, the percentage errors in the option valuation can be larger as the number of outstanding options falls. In the original case for P_o = $20 (shown in Column A of Table 1) and where the options comprised about 5% of the company's total value, the estimation error was 11.3%. Now suppose there are only 100 options in each tranche, which means that the options comprise only about 1.7% of the total value of the company. Estimating the total value of the options by using the summary statistics as a single tranche rather than the estimating separately the value of each tranche would cause an investor to overstate the value of the options by about 13.5%. Notice that this is a larger estimation error than for the previous example in which the options comprised a larger percentage of the company's value.

Even if a company reported the actual exercise price and remaining contractual time until expiration for each unique option grant (or at least reported more homogeneous groupings based upon exercise price and time until expiration), there are other company-specific factors that affect the value of outstanding grants. As noted earlier, some employees will forfeit underwater options by leaving the company after the options vest but before they expire, and some employees will exercise their options prior to the expiration date. Due to the company's knowledge about the different features of each option tranche, the historical employee attrition

rate, and the historical early exercise record, the company is in a much better position to estimate the expected time until exercise than are investors. In fact, SFAS 123 requires companies to take into account the factors described above, such as the expected time until exercise (instead of the contractual time until exercise) when estimating the fair value of the options at the grant date. But SFAS 123 does not require companies to report the expected time until exercise to investors, even though that can have a large impact on estimated warrant prices.

Continuing with the same numerical example, suppose that the company in the illustration above has experienced considerable early exercise when its employee stock options are in the money. Suppose that the company's best estimate is that the effective time until exercise for the second tranche (which has nine years until contractual expiration) is actually three years when those options are in the money.[13] Table 3 repeats the calculations reported in Table 2, except for cases in which the options in the individual tranches are in the money. In those cases, the option values are based upon the effective three-year time until exercise based upon the company's experience. As Table 3 shows, these errors in estimating the value of the options are very large.

As the examples above illustrate, current reporting conventions are insufficient for investors to estimate accurately the value of option grants. This is in stark contrast to the reporting conventions for many other claims against the company. For example, companies don't report the complete bond indentures for each bond, but they do report sufficient data so that an investor can make a reasonable estimate of the bond's value. For many complex debt instruments, such as long-term interest-rate swap agreements, the company is even required to make a fair value adjustment. Also, many claims, such as debt and preferred stock, are often publicly traded, so actual market prices and other details about the issue are available. Thus, sufficient information is available to value other claims against the company.

[13] The effective time until exercise is likely a function of the degree to which the option is in the money. But for clarity of exposition, the example assumes that the effective time until exercise is simply 3 years no matter how far into the money is the option.

Table 3: The Impact of Nonlinearity and Early Exercise on Estimated Option Values.

The table shows the percentage errors in resulting option values when option values are calculated as a single combined tranche instead of correctly calculated separately as the two individual tranches. The effective time until exercise of three years replaces the actual time until expiration for options that are in the money and that have actual times until expiration greater than three years. The percentage errors are based on the total value of all outstanding options, not on the price per individual option. For all columns, the standard deviation of the underlying asset is 0.427 and there are 322 options per tranche. The fundamental stock price is assumed to equal the observed stock price in all cases. Differences in exercise prices, maturity, and the risk free rate are shown for each tranche for each column.

	Column A		Column B		Column C		Column D	
Tranche:	1	2	1	2	1	2	1	2
Exercise Price:	$27	$13	$27	$13	$27	$13	$20	$20
Contractual Time Until Expiration (years):	1	9	9	1	5	5	1	9
Risk free rate:	1.41%	4.01%	4.01%	1.41%	3.17%	3.17%	1.41%	4.01%

Stock Price	% Error	% Error	% Error	% Error
$2.00	-85.5%	-61.2%	-42.5%	-74.8%
$4.00	-65.2%	-26.0%	-30.7%	-47.0%
$6.00	-47.4%	-4.8%	-24.0%	-25.3%
$8.00	-32.2%	3.4%	-19.5%	-8.9%
$10.00	-19.5%	3.5%	-16.2%	2.4%
$12.00	-9.2%	0.7%	-13.7%	9.3%
$14.00	58.4%	-2.4%	25.5%	129.1%
$16.00	52.8%	-5.0%	21.1%	99.8%
$18.00	47.6%	-6.8%	17.8%	78.3%
$20.00	42.7%	-8.0%	15.2%	62.3%
$22.00	38.0%	-8.7%	13.2%	50.3%
$24.00	33.7%	-9.1%	11.5%	41.0%
$26.00	29.8%	-9.2%	10.0%	33.8%
$28.00	26.3%	12.7%	8.8%	28.1%
$30.00	23.1%	10.6%	7.8%	23.6%
$32.00	20.3%	9.0%	6.9%	19.9%
$34.00	17.9%	7.6%	6.2%	16.9%
$36.00	15.7%	6.5%	5.5%	14.4%
$38.00	13.9%	5.6%	4.9%	12.4%
$40.00	12.2%	4.8%	4.4%	10.7%

Note: the highlighted values are those for which the effective maturity of three years has replaced the actual maturity.

In summary, there can be significant errors in estimated option values when the reported summary statistics are used rather than the unreported individual exercise prices and times until expiration and exercise.

IV. Estimating the Fundamental Stock Price: A Numerical Example

This section examines the case in which the fundamental stock price might not equal the observed market stock price and illustrates how an investor can calculate simultaneously the value of the options and the fundamental stock price. As the example illustrates, there can be significant errors when the fundamental stock value is estimated using stock option summary information currently provided by companies.

When estimating the fundamental stock price with an entity valuation model, the analyst first estimates the total value of the firm, Q, usually by first estimating the value of operations as the present value of the projected free cash flows.[14] Suppose there are k different tranches, with m_i denoting the number of warrants for tranche i and ω_i denoting the value of the option in tranche i. Given an estimate of Q, to calculate the option price for the i^{th} option tranche, the adjusted stock price of Equation (6) is replaced with:

$$P^* = \left(\frac{Q - \sum_{j=1}^{k} m_j \omega_j}{n} \right) e^{-qT} + \frac{m_i \omega_i}{n} \qquad (6a)$$

[14] As shown in Equation (2), the free cash flows are discounted at the weighted average cost of capital. It is important to keep in mind that even though the presence of securities with conversion features causes component capital costs, such as the cost of equity, to vary over time, this does not the overall WACC to vary. Also, as noted earlier, other entity valuation approaches, such as the use of EBITDA multiples, can be used to estimate Q.

In other words, the observed stock price in Equation (6) is replaced with an estimate of the fundamental stock price given by Equation (4). Given this substitution, Equations (6a) through (10) are solved simultaneously for all option tranches and the fundamental stock price.[15] As this shows, if an analyst wishes to estimate the fundamental stock price for a company that has issued employee stock options, the analyst must estimate the fundamental stock price in conjunction with the option values. In other words, the analyst cannot estimate the fundamental stock price without also estimating the option values. Thus, the company's reported option data play a key role in estimating the fundamental stock price.

For this example, Q, the combined value of the quasi-equity, is allowed to vary in order to illustrate the relationship between the estimation errors and "in-the-moneyness." There are 322 options per tranche, with the options comprising roughly 4%-5% of the firm's total value, depending upon the value of Q. Both tranches have exercise prices of $20; therefore, the company reports summary statistics for a single group of options. The weighted-average exercise price reported in its summary statistics is $20. The first tranche has one year remaining until exercise and the second tranche has nine years remaining until exercise; therefore, the company reports a contractual weighted average time until expiration of five years in its summary. Based upon the company's past experience, the options have an effective time until exercise of three years if the options are in the money. This three-year effective time until exercise replaces the nine-year contractual time until expiration for options in the second tranche when those options are in the money. The one-year risk free rate is 1.41%, the three-year rate is 2.27%, the five-year rate is 3.17%, and the nine-year rate is 4.01%. The standard deviation of the underlying asset (i.e., the standard deviation of Q) is 0.427.

Table 4 shows the percentage errors in estimated fundamental stock values and in estimated option values when the reported summary statistics are used rather than the unreported

[15] These simultaneous equations are actually all implicit functions, but Excel can solve them quite easily using the iteration feature. Notice that this approach does not take into account the impact that one option has on another via the change in number of outstanding shares of stock and proceeds that may occur if one of the options is exercised. In other words, this does not perform an equivalent calculation as the Dennis and Rendleman (2004) model. But as they noted for situation in which options comprise a relatively small portion of Q, their calculated option prices are very close to those that are calculated when ignoring the impact that one option has on another via the change in number of outstanding shares of stock and proceeds that occur if one of the options is exercised. Thus, the estimated option values from Equations (6a)-(10) are slightly biased upward, and the estimated fundamental stock price is slightly biased downward. However, the estimated option prices are consistent in the sense that they the same that would be estimated if the observed stock price were equal to the fundamental stock price and Equations (6) – (10) were used to estimate option prices as in Section III.

actual exercise prices and times to expiration for the two individual tranches. As shown in Column A of Table 4, the errors in estimated option values can be substantial if the summary statistics are used instead of the appropriate data for the individual tranches, especially if the effective time to exercise differs from the contractual time to expiration. This is similar to the results in Tables 2 and 3 in which the market price of the stock was assumed to equal the fundamental value of the stock.

Column B of Table 4 shows the fundamental stock prices when correctly calculated using the unreported data for the two individual tranches; Column C shows the fundamental stock prices based upon the reported summary statistics. As shown in Column D, the estimation error is small for options that are out of the money, but is on the order of $0.30 to $0.50 for options that are in the money and so have shorter effective remaining times until exercise. Even though the estimated option values are not very accurate, the errors in estimated fundamental prices are not very large because the options comprise a relatively small proportion of total value.

To explore the impact on estimation errors for firms with more outstanding options, the number of options is increased from 322 per tranche to 1128 per tranche, which causes options to comprise about 11%-15% of the firm's total value. As shown in Column D of Table 5, the resulting errors in estimated fundamental stock prices are on the order of $0.50 to $1.00 for those situations in which options are in the money and have shorter effective lives.

As these examples illustrate, investors may not be able to accurately estimate the value of outstanding option grants or the fundamental stock price using the information provided by current disclosure requirements.

Table 4: The Impact of Nonlinearity and Early Exercise on Estimated Fundamental Stock Prices and Employee Stock Option Values when Options Comprise a Small Proportion of the Firm's Value

There are 322 options per tranche, which means that options comprise roughly 4%-5% of the firm's total value. Both tranches have exercise prices of $20; a $20 exercise price is also reported for the combined tranche. The first tranche has one year remaining until exercise and the second tranche has nine years remaining until exercise; five years is reported for the combined tranche as the time until exercise. The effective time until exercise of three years replaces the actual time until expiration for options in the second tranche that are in the money. The one-year risk free rate is 1.41%, the three-year rate is 2.27%, the five-year rate is 3.17%, and the nine-year rate is 4.01%. For all calculations, the standard deviation of the underlying asset is 0.427. The table shows the percentage errors in estimated fundamental option values when calculated as a single combined tranche instead of correctly calculated separately for the two individual tranches. The table also shows the fundamental stock prices when correctly calculated using the two individual tranches and also when calculated using the single combined tranche.

	Column A	Column B	Column C	Column D
Q, the combined value of equity and options ($)	Error in estimated option values (%)	Fundamental stock price based on both tranches ($)	Fundamental stock price based on summary statistics of combined tranche ($)	Error in estimated fundamental stock price
$28,236	-16.4%	$6.92	$6.94	$0.02
$34,824	-5.3%	$8.50	$8.52	$0.01
$41,412	2.6%	$10.08	$10.07	-$0.01
$48,001	7.7%	$11.64	$11.61	-$0.03
$54,589	10.7%	$13.19	$13.14	-$0.05
$61,177	11.9%	$14.72	$14.66	-$0.07
$67,766	12.1%	$16.25	$16.16	-$0.08
$74,354	11.6%	$17.76	$17.66	-$0.10
$80,943	10.7%	$19.26	$19.15	-$0.10
$87,531	70.7%	$18.05	$17.66	-$0.38
$94,119	59.2%	$19.56	$19.15	-$0.40
$107,296	50.0%	$21.05	$20.64	-$0.41
$120,473	42.6%	$22.54	$22.12	-$0.42
$133,649	31.6%	$25.49	$25.07	-$0.42
$146,826	24.0%	$28.41	$28.00	-$0.41
$160,003	18.6%	$31.31	$30.92	-$0.39
$173,179	14.7%	$34.20	$33.83	-$0.37
$186,356	11.7%	$37.08	$36.74	-$0.34
$199,533	9.4%	$39.95	$39.64	-$0.31
$212,709	7.6%	$42.82	$42.53	-$0.29
$225,886	6.2%	$45.68	$45.42	-$0.26

Table 5: The Impact of Nonlinearity and Early Exercise on Estimated Fundamental Stock Prices and Employee Stock Option Values when Options Comprise a Larger Proportion of the Firm's Value

For all calculations, the standard deviation of the underlying asset is 0.427. There are 1128 options per tranche, which means that options comprise roughly 11%-15% of the firm's total value. Both tranches have exercise prices of $20; a $20 exercise price is also reported for the combined tranche. The first tranche has one year remaining until exercise and the second tranche has nine years remaining until exercise; five years is reported for the combined tranche as the time until exercise. The effective maturity of three years replaces the actual time until expiration for options in the second tranche that are in the money. The one-year risk free rate is 1.41%, the three-year rate is 2.27%, the five-year rate is 3.17%, and the nine-year rate is 4.01%. The table shows the percentage errors in estimated fundamental option values when calculated as a single combined tranche instead of correctly calculated separately for the two individual tranches. The table also shows the fundamental stock prices when correctly calculated using the two individual tranches and also when calculated using the single combined tranche.

	Column A	Column B	Column C	Column D
Combined value of equity and options ($)	Error in estimated option values (%)	Fundamental stock price based on both tranches ($)	Fundamental stock price based on summary statistics of combined tranche ($)	Error in estimated fundamental stock price
$28,236	-26.3%	$6.65	$6.76	$0.11
$34,824	-16.1%	$8.12	$8.21	$0.10
$41,412	-8.5%	$9.55	$9.62	$0.07
$48,001	-3.0%	$10.95	$10.99	$0.03
$54,589	0.7%	$12.33	$12.32	-$0.01
$61,177	3.1%	$13.68	$13.63	-$0.05
$67,766	4.4%	$15.00	$14.92	-$0.09
$74,354	5.0%	$16.29	$16.18	-$0.12
$80,943	5.1%	$17.56	$17.42	-$0.14
$87,531	5.0%	$18.81	$18.65	-$0.15
$94,119	4.6%	$20.03	$19.87	-$0.16
$107,296	28.2%	$23.26	$22.26	-$1.00
$120,473	21.6%	$25.59	$24.62	-$0.98
$133,649	16.8%	$27.87	$26.94	-$0.93
$146,826	13.3%	$30.11	$29.24	-$0.87
$160,003	10.6%	$32.33	$31.52	-$0.81
$173,179	8.5%	$34.53	$33.78	-$0.74
$186,356	6.9%	$36.71	$36.03	-$0.68
$199,533	5.5%	$38.88	$38.27	-$0.61
$212,709	4.5%	$41.04	$40.50	-$0.54
$225,886	3.6%	$43.20	$42.72	-$0.48

V. Summary

As stated by the SEC and FASB, the primary objectives of financial statements are to provide investors with adequate information to allocate capital efficiently. To make capital allocation decisions, equity investors need sufficient information to estimate the fundamental value of equity. As shown in this paper, current disclosure requirements for employee stock option plans are insufficient. Following are two recommendations to address this problem.

As the previous numerical examples illustrate, the current practice of grouping options by exercise price and reporting only summary statistics (the weighted average exercise price and the weighted average contractual time until expiration) for the group is inadequate. This practice produces groups that are not sufficiently homogeneous, because the range of exercise prices and times to expiration within the group are too large. Ideally, companies should report each unique tranche based upon grants with identical exercise prices and identical remaining times until expiration. If the number of outstanding option tranches is so large that this becomes impractical, then companies should group options according to a small range for both exercise price and remaining times until expiration, with summary statistics reported for these more homogeneous groups.

Second, investors also need information regarding the company's experience with early exercise, because this has a large impact on estimated option values. Companies are currently required to estimate the expected time until exercise for newly granted options at the time of the grant. Companies should also be required to update their estimates of expected time until exercise and report this data in addition to the contractual time until expiration.

Implementation of these two recommendations would enable investors to make better estimates of the fundamental value of equity, make better capital allocation decisions, and, thus, help the SEC and FASB better achieve their objectives.

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