

The Economic Dilution of Employee Stock Options: Diluted EPS for Valuation and Financial Reporting

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ABSTRACT

We derive a measure of diluted EPS that incorporates economic implications of the dilutive effects of employee stock options. We show that the existing treasury stock method of accounting for the dilutive effects of outstanding options systematically understates the dilutive effect of stock options, and thereby overstates reported EPS. Using firm-wide data on 731 employee stock option plans, we find that economic dilution from options in our measure of options-diluted EPS is, on average, 100% greater than dilution in reported diluted EPS using the treasury stock method required by SFAS No. 128. Incremental dilutive shares from stock options in the denominator of our measure of options-diluted EPS average 3.0% of common shares outstanding compared to 1.5% in reported diluted EPS.

We also examine the implications of our analysis for stock price valuation, the price-earnings relation, and the return-earnings relation. We demonstrate that when firms have options outstanding, empirical applications of equity valuation models that utilize reported per share earnings as an input (e.g., Ohlson, 1995), will yield upwardly biased estimates of the market value of common stock. We also illustrate that observed return-earnings and price-earnings coefficients are expected to be smaller when the difference between our measure of dilution from options and reported dilution from options is greater. We find mixed support for this hypothesis when we use reported earnings, and strong support for the hypothesis when we adjust reported earnings for an estimate of the expense of the new options grant.

Data Availability: All data are available from public sources.

I. INTRODUCTION

Firms are using employee stock options more frequently and in sharply larger quantities than just a decade ago. For example, the median number of shares reserved for stock options as a percentage of shares outstanding for all firms on Compustat increased monotonically from 4.6% in 1985 to 8.9% in 1995.¹ This rapid growth has drawn intense scrutiny from the investment community, including individual and institutional shareholders, analysts, standard setters, and regulators, many of whom are concerned that diluted earnings per share (diluted EPS) understates stock options' effect on corporate earnings.

As a summary assessment of a corporation's current performance, the EPS number and forecasts of expected EPS are central to fundamental analysis, equity valuation, and performance evaluation (e.g., Frankel and Lee, 1998; Dechow, Hutton, and Sloan, 1999). Investors and analysts have at least two concerns about the economic impact of employee stock options on EPS. First, what are a firm's earnings net of the compensation expense for newly granted employee stock options? That is, what is the appropriate *numerator* in the EPS calculation? Second, regardless of how income reflects the cost of newly granted stock options, how much do firms' outstanding options (i.e., previous grants) dilute existing shareholders' claims? That is, what is the appropriate *denominator* in the EPS calculation?

While we document that both of the above concerns have a substantial effect on EPS, the primary focus of this study is on the mis-measurement of the *denominator* in the EPS calculation. Regardless of whether new grants of options are expensed in the numerator, if diluted EPS is used for

¹ The number of shares reserved for stock options is equal to the number of stock options outstanding plus the number of shares authorized for future grants.

valuation, it is important that the number of dilutive shares in the denominator of EPS accurately reflect the dilution that new and previously granted options cause common stockholders.² The intuition for this denominator effect is as follows. Suppose that a firm has vested employee stock options outstanding, but has granted no new options. This assumption of completely vested options and no new grants simplifies the illustration because there is no argument that earnings in the numerator of EPS should be reduced by any option expense. Because of the outstanding stock options, whose value is directly linked to the value of common stock, this firm's aggregate earnings do not accrue solely to the common stockholders. Both the optionholders and stockholders have an economic claim on the firm's earnings, and the two sets of claimholders share the capitalized value of these earnings.

We extend the work of Huson, Scott, and Weir (1999). They document that the stock return response to changes in accounting income is smaller for firms with a greater number of shares reserved for conversion.³ They also show that the return-earnings response is smaller for firms with higher recent returns, where recent returns are used as a proxy for the extent to which options and convertible securities are in the money. Their empirical evidence is consistent with (i) the notion that optionholders and other convertible securityholders have a claim on firms' earnings; (ii) this claim becoming proportionately greater when the options and convertibles are further in the money; and (iii) the market reflecting the dilution of options and convertibles in stock prices. However, in contrast to Huson et al.,

² Statement of Financial Accounting Standards No.123, "Accounting for Stock-Based Compensation" does not require firms to expense most stock option grants, but does require an estimate of expense to be disclosed in the footnotes to the annual report.

³ Shares reserved for conversion is the sum of: (i) the maximum number of shares issuable upon conversion of convertible debt and preferred stock, (ii) the number of stock options outstanding plus the shares authorized for future grants, and (iii) the number of outstanding warrants plus any other miscellaneous shares reserved for conversion.

we examine the extent to which reported diluted EPS adequately captures the dilution of options, and describe how the EPS measure can be adjusted to reflect the dilutive implications of stock options.

We extend and formalize the work of Huson et al. by deriving a method to partition earnings between stockholders and optionholders based on their relative economic claims. We show how this method can be used to generate a measure of options-diluted EPS that is appropriate for valuation and also potentially for financial reporting. We also document the extent to which reported diluted EPS fails to account for the stock options' dilutive effect, and that this error is reflected in stock prices as predicted.

We begin our analysis by noting that the portion of total equity value attributable to optionholders is a function of the value of total outstanding stock options relative to the value of common stock. We use this relation to allocate earnings between stockholders and optionholders, and show how the earnings allocated to stockholders can be scaled to obtain a measure of options-diluted EPS that reflects the per share claim common stockholders have on the firm's earnings. In addition, we derive the relation between *changes* in earnings and stock *returns* and show that the portion of equity value change captured by optionholders is a function of the sensitivity of outstanding options to a change in stock price (i.e., the option delta). For example, other things equal, the value and delta of an "in the money" option is greater than the value and delta of an "out of the money" option. As such, an in the money option has a claim on firm performance that is greater than that of an out of the money option and closer to a share of common stock.

Our empirical analysis finds that reported diluted EPS systematically underestimates the dilutive effect of employee stock options. In a sample of 731 large firms over the period 1994-1997, the average economic dilution due to stock options is equivalent to 2.96% of weighted average common

shares outstanding. Reported diluted EPS reflects the dilution of stock options using the treasury stock method. The average dilution due to stock options under the treasury stock method (defined below) is only 1.46% of weighted average common shares outstanding. Further, for intensive users of stock options, such as high growth firms, the difference between treasury stock method dilution and the estimated dilutive effect of options is as much as 8% of weighted average shares outstanding.

We also examine the implications of our analysis for stock price valuation, the price-earnings relation, and the return-earnings relation. We demonstrate that when firms have options outstanding, empirical applications of equity valuation models that utilize reported per share earnings as an input (e.g., Ohlson, 1995), will yield upwardly biased estimates of the market value of common stock (see also Ohlson, 2000 for a discussion of problems with empirical applications of this model in the presence stock options). Further, we illustrate that observed return-earnings and price-earnings coefficients are expected to be smaller when the difference between our measure of dilution from options and reported dilution from options is greater. Our empirical evidence provides some support for this hypothesis, although our results are sensitive to specification issues. We find strong evidence in favor of our prediction when we specify earnings net of an estimate for the current year's stock option expense. Bell, Landsman, et al, and Aboody, Barth and Kasnik document that stock prices reflect stock option expense. We find mixed evidence for our hypothesis when we specify earnings without a deduction for current year option expense.

Section II explains the treasury stock method of calculating diluted EPS and our method of adjusting diluted EPS to account for the effect of dilutive securities in a firm's capital structure. Section III describes sample selection and presents descriptive statistics on the sample firms' option plans and the reported and economic dilutive effects of these plans. In Section IV, we test whether the economic

dilutive effect of stock options that we calculate is reflected in stock prices and returns. We summarize the paper and discuss its implications in Section V.

II. COMPUTING DILUTED EPS

In Section II.1, we summarize how reported diluted EPS is computed using the treasury stock method required by SFAS No. 128. In Section II.2, we introduce a measure of EPS that reflects the economic dilutive effects of employee stock options. Section II.3 compares our measure of options-diluted EPS to reported diluted EPS, and discusses the implications of the differences between these measures. We operationalize the measure of options-diluted EPS for explaining returns in Section II.4.

II.1 EPS Calculation Under the Treasury Stock Method

SFAS No. 128 requires two earnings per share calculations, basic EPS and diluted EPS. Basic EPS is simply earnings available to common stockholders divided by weighted average common shares outstanding. As recognized in the Accounting Principles Board Opinion No. 15 (1969) and demonstrated empirically by Aboody (1996) and Huson, Scott, and Weir (1999), basic EPS is deficient as a summary performance measure because it does not reflect the share of firm performance that is attributable to dilutive securities. To address this shortcoming, diluted EPS adds incremental shares to the weighted number of shares used in computing basic EPS.

The treasury stock method is used to calculate the incremental dilutive shares due to stock options under both SFAS No. 128 and Accounting Principles Board Opinion No.15. Under the treasury stock method, the number of incremental dilutive shares due to options is equal to the difference between the number of common shares that would be issued upon exercise of the options and the number of common shares that can be purchased with the proceeds from option exercise. If all

of a firm's options have the same exercise price, then the incremental dilutive shares due to options can be simply expressed as:

$$\text{Treasury stock method dilutive shares from options} = N_o \max[0, (P - X)/P]$$

where N_o is the number of options outstanding, P = price per share of the firm's common stock and X = exercise price of each option.⁴ When the exercise price of the options exceeds the stock price, the number of incremental dilutive shares is set equal to zero, thereby restricting diluted EPS to be less than or equal to basic EPS.

When the firm's only outstanding dilutive securities are options, SFAS No. 128 diluted EPS is computed as follows:

$$\begin{aligned} \text{FASB diluted EPS} &= \frac{E}{(N_s + N_o[(P - X)/P])} \\ &= E * g_{\text{FASB}} \end{aligned} \tag{1}$$

where N_s is the number of common shares outstanding, and g_{FASB} is a scaling factor on earnings equal to $1/[N_s + N_o((P - X)/P)]$ that produces FASB diluted EPS when it is multiplied by total earnings E .

In this study, we focus on the dilutive effects of employee stock options, and ignore diluted EPS reporting and valuation issues related to convertible debt, convertible preferred stock and warrants. In our sample, stock options account for more than 80% of all incremental dilutive shares used in reported diluted EPS. Thus, the dilutive effects of other convertible securities are expected to be of secondary importance, at least on average. Further, because the FASB requires the if-converted method to

⁴ If a firm has tranches of options N_{oi} outstanding with differing exercise prices X_i , the incremental shares are computed by summing $\max(0, P - X_i/P) * N_{oi}$. Also, the treasury-stock method requires that the average stock price and number of options outstanding over the fiscal period be used in computing incremental shares. While we do take these averaging issues into consideration in our empirical work, in our formal analysis, we assume a single price, P , and a constant number of outstanding options, N_o , without loss of generality. From this point forward, for notational simplicity we assume that the options are on average in the money, and use $(P - X/P)$ in place of $\max(0, P - X/P)$.

incorporate the dilutive effects of convertible debt and preferred stock into diluted EPS, an analysis of the dilutive effects of these securities is substantially more complex than for stock options.⁵

II.2 Explaining Stock Prices with Options- Diluted EPS

To derive economic diluted EPS, we assume that the value of equity is a function of current aggregate earnings, E:

$$V_{equity} = V_{equity}(E) \quad (2)$$

This valuation form is quite general and can be obtained as a transformation of the dividend-discount model of equity valuation (e.g., Williams, 1938, Gordon, 1962, Fama and Miller, 1972, Collins and Kothari, 1989, and Ohlson, 1995). In the presence of options (or other securities) that can be converted into common stock, the value of equity is the sum of the value of the common stock and the value of options:

$$\begin{aligned} V_{equity}(E) &= V_{stock}(E) + V_{options}(E) \\ &= PN_S + ON_O \\ &= P[N_S + N_O(O/P)] \end{aligned} \quad (3)$$

where V_{stock} = value of the firm's common stock, where $V_{options}$ = value of the firm's outstanding options, and where O = value per outstanding option. Equation (3) can be re-expressed as the per share value of the common shareholder's equity:

⁵ The if-converted method sets incremental dilutive shares equal to the number shares that would be issued upon conversion of the security and adds back the corresponding dividends or interest expense to income. Unlike the treasury stock method for options, which we show systematically underestimates the economic dilution from options, the if-converted method can overstate or understate the number of economic incremental shares for convertibles depending on the relative magnitudes of the numerator and denominator effects and whether individual securities are determined to be dilutive or anti-dilutive. In addition, it is unclear theoretically whether the entire amount of interest expense or dividends should be added back to the numerator of EPS, as the holders of the convertibles bear a portion of these costs.

$$P = \frac{V_{equity}(E)}{N_s + N_o(O/P)} \quad (4)$$

An immediate implication of Equation (4) is that commonly-used models that express common stock value as a function of earnings or earnings and book value of equity (e.g., Ohlson, 1995) can be misspecified in the presence of stock options. To see this, first consider a price-earnings-multiple valuation model:

$$V_{equity} = kE \quad (5)$$

where k is the price-earnings multiple. Equation (5) yields an upward biased share price for a firm with stock options outstanding unless E is deflated by $[N_s + N_o(O/P)]$:

$$P = \frac{kE}{[N_s + N_o(O/P)]} \quad (6)$$

In this setting, the common shareholders' per share earnings, or the options-diluted EPS is:

$$\begin{aligned} \text{Options - diluted EPS} &= \frac{E}{[N_s + N_o(O/P)]} \quad (7) \\ &= E * \gamma_{\text{ECON}} \end{aligned}$$

where $\gamma_{\text{ECON}} = 1/[N_s + N_o(O/P)]$ is a scaling factor that transforms aggregate earnings to obtain Options-diluted EPS.

More generally, consider the residual income model:

$$V_{equity}(E)_t = \mathbf{p}_0 BV_t + \mathbf{p}_1 E_{t+1} + \dots + \mathbf{p}_k E_{t+k} \quad (8)$$

where BV is the book value of equity, and E_{t+k} are forecasts of future residual earnings. In this model, book value, earnings, and forecasted earnings must be deflated by $[N_s + N_o(O/P)]$ to yield a correct price as in Equation (4).

II.3 Explaining Stock Returns Using Options-Diluted EPS

In Section II.2, we derive options-diluted EPS in a setting where stock price is modeled as a function of the level of earnings. Frequently, researchers and practitioners are interested in contexts where stock *returns* are modeled as a function of earnings *changes*. To derive the relation between change in equity value and change in earnings, we return to Equation (3) and assume that the change in equity value for a dollar of unexpected aggregate accounting earnings, or the earnings response coefficient, is k .⁶ Thus, when we differentiate Equation (3) by E, we obtain:

$$\begin{aligned} \frac{dV_{equity}(E)}{dE} &= k = \frac{dP}{dE} N_s + N_o \frac{dO}{dP} \frac{dP}{dE} \\ k &= \frac{dP}{dE} \left[N_s + N_o \frac{dO}{dP} \right] \\ k &= \frac{dP}{d(E/N_s)} \left[\frac{1}{N_s} \right] \left[N_s + N_o \frac{dO}{dP} \right] \end{aligned} \quad (9)$$

Note that (E/N_s) is basic EPS, so upon rearranging, we obtain the following expression:⁷

$$\frac{dP}{d(E/N_s)} = k * N_s * \frac{1}{N_s + N_o(dO/dP)} \quad (10)$$

which says that the price change is k times the change in basic EPS multiplied by the scaling factor:

$$N_s * \frac{1}{N_s + N_o(dO/dP)} = N_s * \mathbf{g}_{RETURNS} \quad (11)$$

Equation (10) illustrates that the ERC will vary for otherwise identical firms that have different amounts and kinds of stock options outstanding. This implies that commonly used earnings capitalization

⁶ Clearly ERCs are not constant across firms, but vary with firm characteristics. To apply this assumption of constant ERC to our empirical analysis below, we create relatively homogeneous cross-sections of firms where the assumption of a constant earnings response coefficient is *a priori* reasonable.

⁷ Note that this expression is derived for a marginal change in earnings. Specifically, the option delta, dO/dP , is assumed not to change over the marginal change in earnings. In Section IV, we empirically test this expression using

valuation models that underlie the earnings response coefficient literature (e.g., Kormendi and Lipe, 1987, and Collins and Kothari, 1989) are misspecified in the presence of stock options, unless earnings are properly adjusted for the options' dilutive effects .

Like γ_{ECON} , γ_{RETURNS} as a scaling factor that adjusts for the dilutive effect of options. The difference is that γ_{RETURNS} scales changes in earnings such that the sensitivity of common stock value to changes in earnings is comparable across firms with and without options. Accordingly, while γ_{ECON} is driven by the ratio of option price to stock price (O/P), γ_{RETURNS} is driven by the ratio of the *change* in option price to the change stock price (dO/dP).

When there are no options, the scaling factor is one, which means stocks' sensitivity to earnings changes is related to the change in basic EPS. When options are outstanding, share prices will be less sensitive to changes in basic EPS or, if changes in basic EPS are scaled by the scaling factor in Eq. (11), then their sensitivity would be k , the price-earnings multiple. In the Appendix, we provide a simple example that illustrates the intuition behind Equations (7) and (10).

II.4 Error in Using Treasury Stock Method

When a firm has stock options outstanding and positive earnings, options-diluted EPS is less than reported diluted EPS calculated according to SFAS No. 128, and empirical estimation of a regression of price on SFAS diluted earnings will have a regression coefficient that is predictably biased.

To see this, consider the following restatement of Equation (6), which again shows that the relation between stock price and earnings is insensitive to dilution from options when earnings is scaled by

γ_{ECON} :

discrete changes in earnings. Variation in dO/dP due to changes in earnings can induce measurement error in our tests.

$$\begin{aligned}
P &= \frac{kE}{[N_s + N_o(O/P)]} = kE * \mathbf{g}_{ECON} \\
&= kE * \mathbf{g}_{ECON} * \left(\frac{\mathbf{g}_{FASB}}{\mathbf{g}_{FASB}} \right) \\
&= \left[1 - \frac{(\mathbf{g}_{FASB} - \mathbf{g}_{ECON})}{\mathbf{g}_{FASB}} \right] k(E * \mathbf{g}_{FASB})
\end{aligned} \tag{12}$$

In Equation (12), $(E * \gamma_{ECON})$ is Options-diluted EPS. Of course, firms do not report Options-diluted EPS, but instead report options' dilutive effect on EPS using the treasury stock method, or a dilution adjustment to earnings using γ_{FASB} , as in Equation (1). We multiply both sides of Equation (12) by $(\gamma_{FASB} / \gamma_{FASB})$ and re-arrange to derive the relation between price and per reported diluted EPS.

Whereas the SFAS No. 128 method uses the γ_{FASB} scaling factor in assigning fractional equity value to common shareholders, the option-diluted method uses γ_{ECON} as the scaling factor. The error in using SFAS No. 128 earnings is therefore a function of the ratio:

$$\begin{aligned}
\frac{\mathbf{g}_{ECON}}{\mathbf{g}_{FASB}} &= 1 - \frac{(\mathbf{g}_{FASB} - \mathbf{g}_{ECON})}{\mathbf{g}_{FASB}} \\
&= 1 - \frac{N_o(O/P) - N_o[(P - X)/P]}{N_s + N_o(O/P)} \\
&= 1 - \left[\frac{O - (P - X)}{O} \right] * \left[\frac{N_o O}{N_s P + N_o O} \right] \\
&= 1 - [\text{Per Option Error}_v] * [\text{Option Intensity}_v]
\end{aligned} \tag{13}$$

Equation (13) shows that the error in using SFAS No. 128 based earnings to explain stock price is a function of two components: i) the per option error, which is expressed as the percentage

difference between option value, O , and $P-X$, and ii) the value of options outstanding as a fraction of total equity value, which we term “option intensity.”⁸

To illustrate variation in the per option error, Figure 1 plots O/P and $(P-X)/P$ for a typical employee stock option as a function of the price-to-strike ratio (i.e., P/X). We examine options with price-to-strike ratios between 0.5 and 3.0 because in our sample, less than 4% of firms’ option plans have average price-to-strike ratios that are outside these price-to-strike bounds.

Figure 1 illustrates that $(P-X)/P$ is always less than O/P , and therefore, from Equation (14), option-diluted EPS is always less than FASB diluted EPS. This result follows directly from option pricing models that dictate the value of an option is strictly greater than the difference between the stock price and the exercise price. The largest discrepancy between O/P and $(P-X)/P$ occurs when the price-to-strike ratio is around one, that is, the option is “at the money”. For a typical, at-the-money long-duration employee stock option, option value as a fraction of stock price, O/P , is roughly 0.40. Therefore, each option gives rise to 0.40 incremental dilutive shares. On the other hand, the treasury stock method assumes zero incremental shares for at-the-money options because $(P-X)/P$ equals zero. Although the gap between O/P and $(P-X)/P$ shrinks as the price-to-strike ratio increases above 1 or decreases below 1, the deviation between economic dilution and reported dilution is substantial for all cases considered in the figure.

⁸ As a practical matter, the prices used to compute both SFAS No. 128 based diluted EPS and option-diluted EPS reflects average prices for the period over which earnings are computed. The prices used in computing options dilution will not in general be equal to the price after earnings are reported, which will incorporate the information in reported earnings. This difference between the actual price and the price used to compute dilution is an additional source of error in both measures. However, because SFAS dilution is always less than economic option dilution, this error does not change the direction of the bias in using SFAS dilution.

Applying the same logic to equation (10), which links price changes to earnings changes, one can see that:

$$\frac{dP}{d(\text{FASB diluted EPS})} = k - \left[\frac{(\mathbf{g}_{FASB} - \mathbf{g}_{RETURNS})}{\mathbf{g}_{FASB}} \right] k \quad (14)$$

where:

$$\begin{aligned} \frac{(\mathbf{g}_{FASB} - \mathbf{g}_{RETURNS})}{\mathbf{g}_{FASB}} &= \left[\frac{(dO/dP) - [(P-X)/P]}{(dO/dP)} \right] * \left[\frac{N_o(dO/dP)}{N_s + N_o(dO/dP)} \right] \quad (15) \\ &= [\text{Per Option Error}_a] * [\text{Option Intensity}_a] \end{aligned}$$

Equation (15) shows that the error in using SFAS No. 128 based earnings changes to explain stock price change is a function of two components: i) the per option error, which is expressed as the percentage difference between the option delta, dO/dP , and $(P-X)/P$, and ii) option intensity as measured by the change in the value of options outstanding as a fraction of the change in total equity value for a given price change. The dashed line in Figure 1 depicts dO/dP and illustrates that (dO/dP) is always greater than $(P-X)/P$. Further, the gap between (dO/dP) and $(P-X)/P$ is generally much larger than the gap between (O/P) and $(P-X)/P$.

III. SAMPLE AND VARIABLE MEASUREMENT

This section describes our sample selection procedure, explains how we calculate economic dilution due to employee stock options, and provides descriptive statistics on the magnitude and characteristics of the sample firms' stock option plans. The descriptive statistics show that the option plans are economically large for most sample firms, and that there is substantial cross-sectional variation in stock option usage.

III.1 Sample Selection and Descriptive Statistics

Our data come from four sources. First, we obtain an initial sample of 1,059 firms with December fiscal year-ends firms from the 1998 Execucomp database. This database contains a broad sample of small, medium-sized and large firms. Second, we obtain data on outstanding options for fiscal years 1994-1997 from firms' 1997 10-K reports. Third, we use CRSP data to calculate stock returns, stock-return volatility and Treasury bond yields. Finally, we use Compustat as the source for firms' financial data and industry classifications.

We remove firms from the initial sample of 1,059 firms if data is missing from the 10-K, CRSP or Compustat. We exclude firm-years if an acquirer assumes the target company's options in an acquisition. We also remove the firm-year in which a company makes an acquisition using the pooling of interests method, and all firm years prior to this acquisition, because it is not possible to determine the pre-acquisition composition of the firm's option plan. We remove firm-years with losses because existing accounting rules treat the dilutive effects of options differently for firms with negative and positive earnings. Specifically, all options are considered anti-dilutive for firms with losses, whereas only out of the money options are anti-dilutive for firms with positive earnings.⁹ Further, Hayn (1995) and others show that the relation between returns and earnings differs across firms with positive and negative earnings. Finally, we eliminate the most extreme 1% earnings change and return observations. The

⁹ The theory in Section II suggests that optionholders participate in both increases and *decreases* in firm value. As such, options will be dilutive even for firms that report losses. Specifically, the analysis in Section II predicts that having options outstanding will dampen the negative impact of poor earnings on the value of equityholders' claims, which provides a potential explanation for some of the decreased magnitude of ERCs on loss observations.

resulting sample consists of 731 firms and 1,787 firm-years of observations for fiscal years 1995 to 1997.¹⁰

Table 1 summarizes descriptive information about the sample firms' option plans. On average, the firms have 7 million employee stock options outstanding, or 5.8% of reported weighted-average shares outstanding. There is substantial variation in option plan size, with options outstanding as a fraction of weighted average common shares outstanding ranging from 0% to over 31%. The average option plan has a Black-Scholes value of \$164 million with the largest plan valued at over \$9.3 billion. We discuss our use of the Black-Scholes model in detail in Section III.2. The option plan values are a substantial fraction of firms' market capitalization. The value of the average option plan is 3.1% of market value of the common stock, and over 5% of the plans in our sample have a value that exceeds 10% of their firms' stock values. These large plan values are not surprising given the large number of options outstanding and the fact that, on average, the options in these plans are substantially in the money. The mean price-to-strike ratio of the options outstanding is 1.61, indicating that the stock price exceeds the options' exercise price by 61%, on average.

Table 1

III.2 Measuring the Dilutive Effect of Options

Our measure of the dilutive effect of stock options incorporates the optionholders' share of firm value. From Equation (7), the optionholders' share of firm value in the price-earnings-multiple model depends on the number of shares under option, N_o , multiplied by O , the average value of options

¹⁰ We have no observations for 1994, because in order to compare our method with the treasury stock method, we require two years of data (e.g., we use the 1994 and 1995 option data to compute average diluted shares outstanding in 1995).

outstanding. From Equation (11), the optionholders' share of firm performance in the return-earnings-change model depends on the number of shares under option, N_0 , multiplied by dO/dP , the average sensitivity of option value to stock price (i.e., the option delta).

The number of shares under option is easy to identify from the disclosures in the 10-K. The average value and delta of outstanding options is not reported; they must be estimated. To estimate the value and delta of the entire portfolio of outstanding options at the end of the year, we use a modification of the method described in Core and Guay (2000). The essence of this method is to use the Black and Scholes (1973) model as modified by Merton (1973) to account for dividend payouts to calculate the value and delta as if the option portfolio were a single grant. Core and Guay (2000) document that this method yields value and delta estimates that are approximately unbiased in broad samples and highly correlated (> 99%) with the measures that would be obtained if the parameters of the individual options in the portfolio were known.

We note that employee stock options have properties, such as a vesting period and nontransferability, that deviate from the assumptions underlying standard option pricing models (Cuny and Jorion, 1995; Hemmer, Matsunaga, and Shevlin 1994; Huddart, 1994). These features likely contribute to the findings of Hemmer et al. (1996) and Huddart and Lang (1996) that employees tend to exercise options prior to maturity. To address this potential valuation issue, we use two expected times-to-maturity, five years and seven years, when we estimate the Black-Scholes value for the empirical application of our price-earnings model. While our reported results are based on a seven-year maturity, the results are not sensitive to using five years.¹¹

¹¹ To the extent that options are exercised earlier (later) than we assume, our Black-Scholes value will be upwardly (downwardly) biased. For example, the option value-to-price ratio of an at-the-money seven-year option is 0.40 for a

Earnings generated over a fiscal period are a function of the average amount of capital outstanding over that period. As such, both the treasury stock method dilution and our measures of economic dilution in Equations (7) and (14) should be estimated using average stock option capital outstanding over the year. Our data on treasury stock method dilution reflects this averaging procedure. However, because data on options outstanding are disclosed only as of the fiscal-year end, we estimate average option value and delta during the year as the average of the beginning of year estimate and the end of year estimate.

SFAS No. 128 Diluted EPS information. We obtain the number of incremental shares that are included in reported diluted EPS directly from the 10-K disclosures. To isolate the dilutive effect of stock options, we separately record the incremental shares due to stock options and other dilutive securities. In about 10% of the firm-years, the incremental shares due to stock options are lumped together with other convertible securities. In these cases, we estimate the treasury stock method incremental shares from options using data from the option plan footnote disclosures. We compute the average of treasury stock method incremental shares at the beginning and end of the fiscal year as a proxy for the actual incremental shares included in reported diluted EPS.

IV. RESULTS

We find that reported diluted EPS substantially understates employee stock options' economic dilutive effect. Specifically, the treasury stock method reflects, on average, only 50% of the incremental

stock with volatility of 30% per year and annual dividend yield of 1% when the risk-free rate is 6%. The ratio decreases to 0.35 if the maturity of the option is reduced to five years. In contrast, however, the Black-Scholes option *delta* used in our empirical application of the return-earnings model is relatively insensitive to the length of the expected exercise period. For most parameter values, the option delta for a two-year option is not substantially different from that of a ten-year option. For example, the delta of an at-the-money seven-year option is 0.672 for a stock with volatility of 30% per year and annual dividend yield of 2% when the risk-free rate is 6%. The delta decreases to slightly 0.667 if the maturity of the option is reduced to five years.

shares implied by our measure of option-diluted EPS. The average deviation between these methods is about 1.5% of common shares outstanding. This deviation is even more severe when comparing the treasury stock dilution to the dilution implied by the returns-earnings-change model. Further, we empirically test the hypothesis that the understatement of stock option dilution in reported EPS is expected to result in downward biased estimates of both the stock return response to reported EPS changes and the stock price response to reported EPS. We find some evidence in support of this hypothesis.

IV.1 Options-Diluted EPS vs. Reported Diluted EPS

Table 2 summarizes the dilutive effect of stock options on EPS in our sample. Panels A and B compare reported diluted EPS against our options-diluted EPS. Panel A of Table 2 reports that the incremental dilutive shares from stock options under the treasury stock method is, on average, 1.46% of common shares outstanding. Panel B of Table 2 shows that the average incremental dilutive shares is 2.96%, which is about 100% larger than the reported dilution under the treasury stock method. The distribution of the data indicate that reported dilution as a fraction of our measure of options dilution is less than 50% for nearly 50% of the firm-years.

Table 2

Descriptive results in panel C report the fraction of a change in equity value attributable to holders of employee stock options. The average incremental dilutive shares implied by the returns-earnings-change model is 4.54% and about 3 times as large as the reported dilutive shares. The maximum dilution from options is 24.9% of common shares outstanding compared to a maximum of 14.5% under the treasury stock method. Further, the distribution of the data indicate that reported dilution as a fraction

of options-dilution is less than 50% for nearly 90% of the firm-years. Intuitively, options' dilutive effect in explaining returns is larger than that in panel B because the ratio of an option's value relative to the stock price (i.e., O/P in Equation (7)) is smaller than the dollar change in option value per dollar change in stock price (i.e., dO/dP in Equation (13)).

IV.2 Understated Dilution and Bias in the Return-Earnings Relation

In this section, we present tests of our hypothesis that the understatement of stock option dilution in reported EPS causes downward biased estimates of the stock return response to reported EPS changes as predicted by Equation (14). In the following Section IV.3, we examine the downward bias in estimates of the relation between stock price and reported EPS as predicted by Equation (12).

For each set of tests in this section, we present results where aggregate earnings in the numerator on EPS are calculated with and without adjusting for an estimate of the cost of new option grants. As discussed in Section I, SFAS No. 123 recommends, but does not require the expensing of most newly granted options. Although none of our sample firms expenses new stock options, investors likely consider the cost of options when setting stock prices (e.g, Aboody, 1996, Aboody, Barth and Kasnik, 2000). To estimate earnings net of options expense, we deduct the pre-tax Black-Scholes value of option grants in a year from reported earnings.¹²

Bias in the return-earnings relation. Section II.3 documents that the incremental dilutive shares from options in reported diluted EPS do not fully capture the economic dilutive effect of options on EPS. Therefore, the relation between changes in common stock value and changes in reported diluted EPS are not expected to be insensitive to the dilutive effects of stock options as derived in Eqs.

(9)-(11). Specifically, we predict that the return-earnings relation is negatively related to the degree to which the treasury stock method understates the economic dilution of options. That is, the greater the overstatement in reported diluted EPS, the lower the earnings response coefficient using reported diluted EPS.

Equation (14) above illustrates this point. Multiplying Equation (14) by the change in FASB diluted EPS and scaling by beginning period price, $Price_{t-1}$, gives the relation between returns and reported diluted EPS as:

$$\text{Return} = \left(k - \left[\frac{(\mathbf{g}_{FASB} - \mathbf{g}_{RETURNS})}{\mathbf{g}_{FASB}} \right] k \right) * \frac{d(\text{FASB diluted EPS})}{\text{Price}_{t-1}} \quad (16)$$

Thus, the return response to an earnings change is expected to be a function of the accuracy of the treasury stock method in estimating the options' dilutive effect. Therefore, we predict that, *ceteris paribus*, the greater the degree of understatement in the treasury stock method, i.e., the greater $(\gamma_{FASB} - \gamma_{RETURNS})/\gamma_{FASB}$, the smaller the response coefficient on reported diluted EPS.

Regression model. We regress annual stock returns on contemporaneous changes in annual earnings per share scaled by beginning of period price. To be consistent with previous studies that estimate earnings response coefficients, we use primary EPS in our regressions for sample years 1994-1996. In accordance with SFAS No.128, primary EPS is not reported for fiscal years ending after December 15, 1997. As a result, we use diluted EPS in sample year 1997. Because the treasury stock method for computing the dilution of options is the same for primary EPS and diluted EPS, our use of two different EPS measures is not likely to affect our results. Further, we anticipate that researchers will

¹² We also perform the analysis using the estimated after-tax Black-Scholes value of the option grants in a year as the expense. We compute this after-tax expense at an assumed marginal tax rate of 40% because all firm-years included have positive earnings. These results are similar to those reported in the paper.

be forced to mix primary and diluted EPS in the future because many studies will likely use data that include pre- and post-1997 earnings numbers.¹³ To ensure that the information in earnings changes is fully reflected in stock returns, we use annual returns beginning in the fourth month of the fiscal year through the third month after the end of the fiscal year.

To measure $(\gamma_{FASB} - \gamma_{RETURNS})/\gamma_{FASB}$, we use Equation (15) above, and term this expression "Dilution error."¹⁴ We empirically estimate the dilution error as $[(\text{options-diluted incremental shares from the return-earnings model} - \text{treasury stock method incremental shares})/(\text{weighted average shares outstanding used in diluted EPS} - \text{treasury stock method incremental shares} + \text{options-diluted incremental shares from the return-earnings model})]$.

We use the following regression to test our predictions:¹⁴

$$\begin{aligned} \text{Return}_t = & a + b [\Delta\text{EPS}_{t-1, t}/P_{t-1}] + c [\Delta\text{EPS}_{t-1, t}/P_{t-1} * \text{Dilution error}_t] \\ & + d [\Delta\text{EPS}_{t-1, t}/P_{t-1} * \text{Control variables}] \\ & + e [\Delta\text{EPS}_{t-1, t}/P_{t-1} * \text{Dilution error}_t * \text{Control variables}] \\ & + \text{Year dummies} + e_t \end{aligned} \tag{17}$$

P_{t-1} is beginning of period price. We predict that b is positive and c is negative. The regression specification includes controls for other determinants of cross-sectional variation in the sample firms' earnings response coefficients, such as size, growth opportunities and risk. As described below, this feature of the empirical design is important because these determinants of earnings response coefficients are also likely to be correlated with the determinants of firms' use of options.

¹³ For the remainder of the paper, we refer to both primary and diluted EPS as "diluted EPS".

¹⁴ Following Biddle, Seow, and Siegel (1995), we also estimate a model including current and lagged earnings separately in place of the earnings change variable. The advantage of including current and lagged earnings separately is that this specification allows the coefficients on those variables to differ, whereas the same coefficient is forced on current and lagged earnings when only the earnings change variable is in the regression model. We also estimated the regression model with the dilution error included as a main effect in addition to the interaction variables. This specification yields similar results to those reported.

We control for influence of these effects on the ERC using two different techniques. In the first method, we include in the regression interactive independent variables where both ΔEPS_t and $\Delta EPS_t * \text{Dilution error}_t$ are interacted with the logarithm of firm value, the ratio of book value of assets to market value of assets, and the standard deviation of stock returns. In the second method, we partition the sample firms into relatively homogeneous groups based on variables that we expect to be correlated with cross-sectional variation in earnings response coefficients, and allow the coefficient on ΔEPS_t to vary across these groups. We also include year indicator variables in all specifications to control for market-wide effects in annual returns.

We estimate the regression models using OLS. Because our data all have December 31 year-ends, there is the potential for our standard errors to be overstated because of cross-sectional dependence. Therefore, we calculate standard errors using the procedure of Froot (1989) under the assumption that cross-sectional correlation occurs within 2-digit SIC code industries, but not across industries. In addition, because we have up to three observations per firm in our pooled regressions, we wish to have standard errors that are robust to autocorrelation. We therefore modify the Froot (1989) standard errors using the method of Rogers (1993), and the resulting standard errors are robust to heteroscedasticity, cross-sectional dependence, and serial correlation in the residuals. We report all t-statistics based on these Froot-Rogers standard errors.

Regression results. Table 3 reports regressions for the pooled sample of 1,787 firm-years from 1994-1997. The first two columns report results with and without control variables for the determinants of ERCs. Without the control variables, the estimated coefficient on the dilution error interacted with the earnings variable is insignificantly positive. On including control variables, the

coefficient on the dilution error has the predicted negative sign, but is insignificant. The coefficients on the controls for other determinants of the ERC have signs consistent with those in Collins and Kothari (1989).

Table 3

The last two columns of Table 3 present results using aggregate earnings calculated by expensing newly granted stock options in the numerator of diluted EPS. Adjusting earnings for the newly granted stock options' Black-Scholes value has mixed results. The dilution error variable is predictably negative without the control variables, but loses significance when we include the control variables.

Results in table 3 are weak for at least two reasons. First, compared to many earnings response coefficient studies like Huson, Scott, and Weir (2001) who use about 60,000 observations, our sample size is less than 2000. Second, the terms interacted with ΔEPS_t in the regression specification cause severe multicollinearity problems. The average pairwise correlation between the change in EPS and each of the other seven explanatory variables in Table 3 is 0.81.¹⁵ This collinearity, combined with our small sample size, substantially reduces the power of our test using the specification in equation (17). The collinearity is magnified because the dilution error term in expression Equation (17) increases in the intensity of firms' use of stock options for incentives ($N_O * dO/dP$). Our controls for cross-sectional variation in the ERC, -- growth, size, and the standard deviation of returns-- are highly correlated with the intensity of firms' use of options for incentive purposes (e.g., Guay, 1999; Core and Guay, 1999; and Bryan, Huang, Lilien, 2000). In particular, prior research shows a strong relation between proxies

¹⁵ The fact that the highest condition index for the regression is 113, and that more than 50% of the variance of three coefficient estimates is associated with this coefficient index suggests severe multicollinearity problems (Belsley, Kuh, and Welsch, 1980).

for firms' growth opportunities and the intensity of firms' use of employee stock options, and also between proxies for firms' growth opportunities and the magnitude of the ERC (e.g., Collins and Kothari, 1989; Biddle and Seow, 1991; and Ahmed, 1994). Thus, the control variables are highly collinear with earnings change interacted with the dilution error variable.

To address the collinearity problem, we re-estimate the regression models and allow the coefficient on the earnings variable to differ by classes of securities that are likely to be relatively homogenous in their earnings response coefficients. To identify these classes of securities, we rank firms on variables that theory suggests are correlated with earnings response coefficients. We describe the ranking variables and results below.

Portfolios ranked on intensity of option use. Equation (14) shows that the dilution error in the returns-earnings model is equal to the product of an error per option multiplied by the fraction of value change due to options. The fraction of value change due to options is largely driven by the intensity of firms' option use. We partition our sample into quintiles based on:

$$\text{Option Intensity} = \left[\frac{N_o(dO/dP)}{[N_s + N_o(dO/dP)]} \right] \quad (18)$$

Because we rank on the intensity of firms' option usage, we expect that the rank variable will be highly correlated with the firms' growth opportunities and other determinants of the ERC. If our expectation is correct, the coefficient on change in earnings will increase across the quintiles, as option intensity is correlated with factors that increase the ERC. Accordingly, this procedure is an alternative to controlling for these determinants with interactive terms, and as such we substantially reduce the collinearity problem. As indicated in Section II.3, our empirical analysis depends on the assumption of a constant ERC, and we expect that these quintiles of firms are sufficiently homogeneous that the assumption of a

constant ERC within each portfolio is plausible. Further, although we create portfolios that are reasonably homogeneous in terms of option intensity, we do not reduce the variation in the per option dilution error for at least two reasons. First, while the option intensity term in Equation (15) is held relatively constant in each portfolio, substantial variation in the per option dilution error, $((dO/dP) - (P - X)/P)/(dO/dP)$ is maintained. Second, the regression is estimated using firm-level data (i.e., there is no data aggregation) and the portfolios simply allow a different earnings response coefficient to each portfolio.

Portfolios ranked on other determinants of earnings response coefficients. In addition to allowing the earnings response coefficient to vary for portfolios of firms ranked on option intensity, we employ a similar approach to rank firms on lagged values of book-to-market ratio (a proxy for growth), size, and the standard deviation of returns.

Results. Table 4 reports results of the following pooled regression in which the coefficients on change in earnings are estimated separately for each quintile ranked either on firms' option intensity or lagged book-to-market ratio:¹⁶

$$\text{Return}_t = a + \sum [D_p * (b_p \Delta \text{EPS}_{t-1, t} / P_{t-1})] + c [\Delta \text{EPS}_{t-1, t} / P_{t-1} * \text{Dilution error}_t] + \text{year dummies} + e_t, \quad (19)$$

where D_p is an indicator variable for each quintile. As before, we report results using aggregate earnings with and without the Black-Scholes option grants expense. The regression specification includes intercept and year indicators, but for compactness we do not tabulate these coefficients. The earnings response coefficients for the more intensive users of options and for low book-to-market portfolios are

¹⁶ An alternative approach is to estimate a different interaction coefficient for each quintile portfolio. However, because of high collinearity among the variables and small differences in coefficient magnitudes that are not estimated very precisely, statistically we gain little from allowing the interaction coefficient to be unique for each

relatively larger. The variation in ERCs across quintiles is consistent with our quintile ranking capturing factors that are associated with determinants of ERCs.

Table 4

Consistent with the hypothesis modeled in Section II, the results in Table 4, suggest that the return response to EPS changes is dampened because the treasury stock method understates economic dilution of stock options. When the portfolios are formed based on option intensity, the coefficient on earnings changes interacted with the dilution error is negative and significant for both measures of earnings. The coefficient of -55 in the first column can be interpreted to mean that a dilution error equal to 1% of weighted average common shares outstanding is associated with a reduction in the ERC of 0.55. Since the dilution error in the returns model averages about 3% for the sample firms, the average decline in the ERC is about 1.65, which represents an economically substantial fraction of the average ERC.

When the portfolios are formed based on a book-to-market ranking, the coefficient on earnings changes interacted with the dilution error is negative and significant for earnings net of option expense, but positive and insignificant for reported earnings. We obtain similar results when we form portfolios by ranking and size and risk: the coefficient on earnings changes interacted with the dilution error is negative and significant for earnings net of option expense, but positive and insignificant for reported earnings.¹⁷

portfolio. Nevertheless, sensitivity tests indicate that the results in Table 4 are robust to allowing the coefficient on the interaction between change in earnings and dilution error to vary across the quintiles.

¹⁷ We also do a three-by-three independent sort on pairs of each of the four variables (book-to-market, size, risk, and option intensity), and allow different earnings response coefficients for the nine portfolios. Similar to our results above, we find that the dilution interaction variable is significantly negative for all pairs of ranking variables when earnings net of option expense is used as the measure of earnings, but significant and negative only for the three

IV.3 Understated Dilution and Bias in the Price-Earnings Relation

In the previous section, we document bias in the return-earnings relation that is a function of the deviation between option dilution embedded in reported diluted EPS and options-diluted EPS. We now examine the bias in a price-earnings levels regression model. To do this, we refer to Equation (13), and calculate dilution error and option intensity as a function of O/P (as opposed to dO/dP in the return-earnings model). This re-specification yields the following regression test:

$$\begin{aligned} \text{Price}_t = & a + \Sigma[D_p * (b_p \text{EPS}_t)] + c [\text{EPS}_t * \text{Dilution error}_t] \\ & + \text{year dummies} + e_t, \end{aligned} \tag{20}$$

where the Dilution error_t is [(options-diluted incremental shares – treasury stock method incremental shares)/(weighted average shares outstanding used in diluted EPS – treasury stock method incremental shares + options-diluted incremental shares)].

Table 5 presents the results from the regression specification in Equation (20) using quintiles formed by ranking the firms on their option intensity as in Equation (13). As with the return-earnings specification, the coefficient on (EPS * Dilution error) is significantly negative using aggregate earnings calculated with or without deducting the option grant expense from the numerator of EPS. Thus, consistent with our hypothesis, our results suggest that the price-earnings relation is dampened when the treasury stock method understates the dilutive effect of stock options.

Table 5

V. SUMMARY AND CONCLUSIONS

sorts that combine option intensity with another variable when reported earnings is used. These results are available on request.

We show that current accounting rules in SFAS 128 systematically understate the dilutive effect of outstanding stock options, thereby imparting an upward bias on reported diluted earnings per share. For firms with positive earnings, FASB diluted EPS is always greater than our derived measure of Options-diluted EPS. Empirical results show that diluted EPS under SFAS No.128 incorporates, on average, only 50% of the incremental shares implied by our measures of option dilution. The deviation in incremental shares between the FASB measure and our measure averages 1.5% of common shares outstanding, and can be as great as 8% of common shares. Further, we present evidence that suggests the understatement of stock option dilution in reported EPS biases downward the response relations between stock returns and earnings changes and between stock price and earnings levels.

The research in this study has important implications for financial analysis, fundamental analysis, and security valuation. Regardless of whether one employs an earnings-based valuation or cash-flow-based valuation model, valuation per share relies on an accurate apportionment of firm equity value among the claimholders, which include shareholders and optionholders (as well as other holders of contingent claims on common stock). The analysis in this study offers insights into this issue both for academic researchers and for standards setters.

An example of interest to academic researchers is that our findings suggest that any research using a variation of the dividend-discount model (such as the Ohlson (1995) residual income-based valuation model) to generate per share stock valuation is mis-specified for a firm that has options in its capital structure. The mis-specification stems from the fact that there is no sharing of equity value with optionholders in these models. Some of our sample firms have options outstanding with a value of 10% of the market value of common stock. For these firms, the price to implied value ratio will be understated by 10%, and empirical estimates of the equity risk premium as in Gebhardt, Lee, and

Swaminathan (1999) will be overstated by about 15%. While Ohlson (2000) is pessimistic about the validity of empirical applications of the residual income model in the presence of stock options, Equation (4) in this paper offers a means of correcting for this mis-specification with a deflator that varies with the characteristics of firms' option plans.

Further, because the treasury stock method systematically understates the dilutive effects of outstanding options, thereby imparting an upward bias on diluted EPS, this accounting treatment is aggressive (i.e., not unbiased or conservative). In contrast to reported diluted EPS, our measure of Options-diluted EPS is consistent with the stated SFAS No. 128 objective to produce an EPS number that reflects the effect of dilutive securities. A practical issue in computing our measure of economic dilution from options is the measurement of employee stock option value. This problem is similar to that addressed in SFAS No. 123 with respect to accounting for the expense of newly granted stock options. The same valuation techniques firms use to record or disclose stock option expense (e.g., modified Black-Scholes) can be employed to estimate economic dilution from stock options. However, we recognize that there remains a concern within the profession about the reliability of option valuation techniques that could render our suggested measures of diluted EPS problematic from a standard-setting perspective. The choice between dilution measures ultimately depends on the FASB's priorities in trading off between conservatism, relevance, and reliability.

APPENDIX

EXAMPLE TO ILLUSTRATE DILUTED EPS CALCULATION SHOWN IN EQUATIONS

(XX) AND (XX)

In this Appendix, we use a two-period example to illustrate how the presence of stock options affects EPS dilution calculations in a price-earnings model and in a returns-earnings model. We first illustrate a price-earnings model for a Company A without options and a Company B with options. We then show how Company B's stock price changes when earnings change and link the returns-earnings model to successive measures of options-diluted EPS. Table A1 below summarizes our assumptions and calculations.

Effect of Options in a Price-Earnings Model. Assume that Company A has no options and 20 shares of common stock. Also assume that the price-earnings multiple and earnings response coefficient is $k = 10$. Therefore, the value of total equity is $(10 \times \text{\$Earnings})$ and equity value increases by \$10 for every \$1 increase in earnings. Because there are no options, the firm's equity value and changes in equity value accrue entirely to common stockholders. Thus, basic EPS is the same as options-diluted EPS and both measures are equal to earnings divided by 20 shares of common stock. For example, if Company A's earnings are \$100, then total equity value = $\$100k = \$1,000$, stock price = \$50 per share and:

$$\text{Basic EPS} = \$100 / 20.0 \text{ common shares} = \$5.00 \text{ per common share; and}$$

$$\text{Options-diluted EPS} = \$100 / 20.0 \text{ dilutive shares} = \$5.00 \text{ per diluted share.}$$

Now consider Company B with a capital structure that consists of 20 shares of common stock and 5 stock options. Assume that Company B's price-earnings multiple and earnings response

coefficient is $k = 10$ and that earnings are \$100, thereby making total equity value = $\$100k = \$1,000$. Also assume that total common stock value is \$900 (i.e., stock price is \$45 per share), that the total value of options is \$100 (i.e., \$20 per option). In this setting:

$$\text{Basic EPS} = \$100 / 20.0 \text{ common shares} = \$5.00 \text{ per common share;}$$

and, from Equation (7),

$$\begin{aligned} \text{Options-diluted EPS} &= \$100 / [N_S + N_O(O/P)] \\ &= \$100 / [20 + 5(\$20/\$45)] \\ &= \$4.50 \text{ per diluted share.} \end{aligned}$$

Thus, Options-diluted EPS achieves the objective of preserving the relation between stock price and the price-earnings multiple (i.e., \$45 per common share = $\$4.50 \times k$).

Effect of Options in a Returns-Earnings change Model. We now illustrate how Options-diluted EPS is applied to the returns-earnings model. Assume Company B's earnings increase by \$20 to \$120 with a resulting increase in total equity value of \$200 (i.e., \$20 earnings increase $\times k$). The new Basic EPS is simply $\$120/20$ common shares, or \$6 per share. To compute the new Options-diluted EPS, we must first determine how the \$200 increase in total equity value is shared between the common stockholders and the optionholders. We assume that, for an increase in equity value of this magnitude, each option's value changes by \$0.70 for a \$1 change in the stock price.¹⁸ From Equations (12) and (13) above, the change in per share stock price is equal to the change in Basic EPS multiplied by the scaling factor γ_{RETURNS} and is expressed as follows:

¹⁸ This example assumes that the firm knows the option delta when it computes diluted EPS, when it will actually be using an estimate of the option delta based on the current stock price, which does not incorporate the information in the earnings change that is about to be released. If the estimate of delta differs from the actual delta (i.e., the actual change in option value divided by the actual change in stock prices), the observed ERC will not equal 10. However provided that the estimate of option delta is unbiased, the average ERC will be 10.

$$\begin{aligned} \text{Change in Stock Price Per Share} &= \frac{\text{Change in Basic EPS}}{[1 + (N_o / N_s)(dO/dP)]} \times k \\ &= \frac{\$1 \text{ per share}}{[1 + (5/20)(0.7)]} \times 10 \\ &= \$8.51 \text{ per share} \end{aligned}$$

Thus, when Basic EPS increases by \$1, the per share stock price increases by \$8.51 to \$53.51. Total common stock value increases by $\$8.51 \times 20 = \170.20 , meaning that 85.1% of the \$200 increase in equity value accrues to common shareholders. The optionholders receive the remaining \$29.80 of the increase in total equity value. Equivalently, when stock price increases by \$8.51 per share, each option increases in value by \$5.96 ($\8.51×0.7) to \$25.96, and total option value increases by \$29.80 ($\5.96×5 options). The new Options-diluted EPS is as follows:

$$\begin{aligned} \text{Options-diluted EPS} &= \$120 / [N_s + N_o(O/P)] \\ &= \$120 / [20 + 5(\$25.96/\$53.51)] \\ &= \$5.351 \text{ per diluted share.} \end{aligned}$$

Thus, Options-diluted EPS again achieves the objective of preserving the relation between stock price and the price-earnings multiple (i.e., $\$53.51 = \$5.351 \times k$).

The table below summarizes the preceding examples:

	Firm A	Firm B _{Year 1}	Change B _{Year 1} to B _{Year 2}	Firm B _{Year 2}
P/E and ERC	10	10	10	10
Earnings	\$100	\$100	\$20	\$120
Total Equity Value	\$1,000	\$1,000	\$200	\$1,200
Shares Outstanding	20	20	0	20
Options Outstanding	0	5	0	5
Stock price	\$50	\$45	\$8.51	\$53.51
Option price	--	\$20	\$5.96	\$25.96
Option delta			\$0.70	
Basic EPS	\$5.00	\$5.00	\$1.00	\$6.00
Options-Diluted EPS	\$5.00	\$4.50	\$0.85	\$5.35

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TABLE 1
Descriptive statistics on firms' option plan characteristics

Descriptive statistics are for a sample of 731 firms and 1787 December fiscal year-end observations from 1995-1997. Option plan details are from the Execucomp database and firms' 1997 10-K reports, stock price data and Treasury bond yields are from CRSP, and financial data are extracted from Compustat. The following observations are excluded from the sample: firm years with losses; firm years in which an acquirer assumes a target firm's options using the pooling-of-interests method of accounting; and extreme 1% of the firm years ranked according to earnings changes and stock returns. Option values are based on the Black and Scholes (1973) model for valuing European call options, as modified to account for dividend payouts by Merton (1973).

	Mean	Std dev	Min	Q1	Median	Q3	Max
Total number of options outstanding, millions	7.01	15.99	0.00	0.99	2.36	5.95	177.22
Total options scaled by reported weighted average shares outstanding, %	5.79	4.74	0.00	2.55	4.74	7.68	31.31
Total value of options outstanding, \$millions	163.95	529.57	0.00	9.91	33.50	111.25	9323.50
Total value of options scaled by market value of common stock, %	3.08	3.07	0.00	1.02	2.17	4.13	20.41
Average price-to-strike ratio of options (excludes firms with no options)	1.61	0.67	0.35	1.18	1.44	1.87	8.96

TABLE 2
Descriptive statistics on dilutive incremental shares and diluted EPS

Descriptive statistics are for a sample of 731 firms and 1787 December fiscal year-end observations from 1995-1997. SFAS No.128 dilution is the number of dilutive incremental shares due to employee stock options reported by the firm. Firms use the treasury stock method to compute dilutive incremental shares from options. Each option's incremental dilutive shares is equal to $[(P-X)/P]$, where P is the average stock price during the year and X is the exercise price of the option. Incremental shares from option dilution are derived in Section II. Incremental dilutive shares are equal to the average of the beginning and end of year average Black-Scholes value for the options in a firm's stock option plan divided by stock price (O/P), and multiplied by the number of options outstanding. Option values and deltas are based on the Black-Scholes formula for valuing European call options, as modified to account for dividend payouts by Merton (1973). Options-dilutive incremental shares for explaining returns are derived in Section II.4. Incremental dilutive shares are equal to the average of the beginning and end of year average Black-Scholes delta (dO/dP, or sensitivity of option value to stock price) for the options in a firm's stock option plan multiplied by the number of options outstanding. All measures of dilution are scaled by the weighted average number of shares used in computing basic EPS.

	Mean	Std dev	Min	Q1	Median	Q3	Max
Panel A: SFAS No. 128 dilution based on (P-X)/P]							
SFAS No.128 dilutive incremental shares scaled by weighted average shares outstanding	1.46%	1.66%	0.00%	0.33%	0.95%	1.96%	14.47%
Panel B: Option-dilution based on O/P							
Options-dilutive incremental shares scaled by weighted average shares outstanding	2.96%	3.00%	0.00%	0.97%	2.07%	3.90%	22.06%
SFAS No.128 dilution / Options dilution	48.35%	24.41%	0%	32.42%	49.64%	65.96%	100.00%
Panel C: Option-dilution for explaining returns, based on dO/dP							
Options-dilutive incremental shares scaled by weighted average shares outstanding	4.54%	4.02%	0.00%	1.81%	3.51%	6.02%	24.90%
SFAS No.128 dilution / Options dilution	30.41%	18.03%	0%	17.87%	29.07%	41.93%	99.88%

TABLE 3

Variation in the return-earnings relation as a function of the dilution error from the treasury stock method

$$\text{Return}_t = a + b [\Delta\text{EPS}_{t-1,t}/P_{t-1}] + c [\Delta\text{EPS}_{t-1,t}/P_{t-1} * \text{Dilution error}_t] + d [\Delta\text{EPS}_{t-1,t}/P_{t-1} * \text{Control variables}_{t-1}] \\ + e [\Delta\text{EPS}_{t-1,t}/P_{t-1} * \text{Dilution error}_t * \text{Control variables}_{t-1}] + \text{year dummies} + e_t$$

The sample contains 731 firms and 1787 firm-year observations from 1995-1997. Dilution error_t = [(Options-diluted incremental shares – SFAS No.128 incremental shares)/weighted average shares outstanding used in diluted EPS] in fiscal year t. Return_t is the annual buy and hold stock return from the fourth month of fiscal year t through the third month after the end of fiscal year t. ΔEPS_{t-1,t}/P_{t-1} is the change in annual earnings per share from fiscal year t-1 to t scaled by stock price at the beginning of period in which returns are measured for fiscal year t. The control variables are firm value (book value of debt plus market value of equity), book value of assets to market value of assets, and the annualized standard deviation of stock returns over the 120 trading days prior to the beginning of year t.

	Earnings w/o B-S option expense adjustment	Earnings w/o B-S option expense adjustment	Earnings with B-S option expense adjustment	Earnings with B-S option expense adjustment
ΔEPS _{t-1,t} /P _{t-1}	2.44 (6.33)	15.28 (1.87)	3.09 (8.69)	11.47 (1.34)
ΔEPS _{t-1,t} /P _{t-1} * Dilution error _t	5.75 (0.56)	-181.68 (-1.07)	-29.16 (-2.38)	-117.46 (-0.53)
ΔEPS _{t-1,t} /P _{t-1} * Firm Value		-0.50 (-1.61)		-0.20 (-0.55)
ΔEPS _{t-1,t} /P _{t-1} * Firm Value * Dilution error _t		9.61 (1.35)		3.74 (0.40)
ΔEPS _{t-1,t} /P _{t-1} * Std. Dev. of returns		-1.58 (-0.47)		-5.03 (-1.08)
ΔEPS _{t-1,t} /P _{t-1} * Std. Dev. of returns * Dilution error _t		-78.66 (-0.83)		31.35 (0.34)
ΔEPS _{t-1,t} /P _{t-1} * Book-to-market ratio		-1.94 (-1.01)		-3.43 (-1.21)
ΔEPS _{t-1,t} /P _{t-1} * Book-to-market ratio * Dilution error _t		11.69 (0.24)		-0.19 (-0.00)
Adjusted R-squared (%)	16.9	17.17	19.5	19.5

t-statistics in parentheses.

TABLE 4

Variation in the return-earnings relation: ERC varies by quintile portfolios ranked on option dilution and other variables

$$\text{Return}_t = a + \sum [D_p * (b_p \Delta\text{EPS}_{t-1,t}/P_{t-1})] + c [\Delta\text{EPS}_{t-1,t}/P_{t-1} * \text{Dilution error}_t] + \text{year dummies} + e_t$$

The sample contains 731 firms and 1787 firm-year observations from 1995-1997. Dilution error_t = [(Options-diluted incremental shares – SFAS No.128 incremental shares)/ weighted average shares outstanding used in diluted EPS] in fiscal year t. Return_t is the annual buy and hold stock return from the fourth month of fiscal year t through the third month after the end of fiscal year t. $\Delta\text{EPS}_{t-1,t}/P_{t-1}$ is the change in annual earnings per share from fiscal year t-1 to t scaled by stock price at the beginning of the period in which returns are measured for fiscal year t. D_p is an indicator variable that takes a value of 1 for the pth quintile, where the quintiles are formed by ranking sample firms on option intensity as defined in Equation (21) of lagged book-to-market values.

	Earnings w/o B-S option expense adjustment: Ranked on option intensity	Earnings w/o B-S option expense adjustment: Ranked on lagged book-to- market	Earnings with B-S option expense adjustment: Ranked on option intensity	Earnings with B-S option expense adjustment: Ranked on lagged book-to-market
$\Delta\text{EPS}_{t-1,t}/P_{t-1}$ - Portfolio 1	2.19 (3.30)	3.24 (3.06)	2.96 (5.54)	4.72 (4.44)
$\Delta\text{EPS}_{t-1,t}/P_{t-1}$ - Portfolio 2	2.59 (4.12)	3.14 (4.06)	3.91 (6.56)	4.46 (4.48)
$\Delta\text{EPS}_{t-1,t}/P_{t-1}$ - Portfolio 3	4.14 (5.37)	1.68 (1.80)	4.47 (4.26)	2.07 (2.60)
$\Delta\text{EPS}_{t-1,t}/P_{t-1}$ - Portfolio 4	4.51 (4.23)	1.87 (2.27)	4.26 (3.21)	3.08 (3.86)
$\Delta\text{EPS}_{t-1,t}/P_{t-1}$ - Portfolio 5	8.31 (4.39)	2.80 (4.48)	8.32 (4.30)	2.88 (4.15)
$\Delta\text{EPS}_{t-1,t}/P_{t-1} * \text{Dilution error}_t$	-55.07 (-2.90)	5.41 (0.54)	-86.49 (-3.00)	-31.10 (-2.67)
Adjusted R-squared (%)	17.9	17.0	20.0	19.7

t-statistics in parentheses.

TABLE 5
Variation in the price-earnings relation

$$\text{Price}_t = a + \sum [D_p * (b_p \text{EPS}_t)] + c [\text{EPS}_t * \text{Dilution error}_t] + \text{year dummies} + e_t$$

The sample contains 731 firms and 1787 firm-year observations from 1995-1997. Dilution error_t = [(Options-diluted incremental shares – SFAS No.128 incremental shares)/ weighted average shares outstanding used in diluted EPS] in fiscal year t. Price_t is the stock price per share at the end of the third month after fiscal year t. EPS_t is the reported earnings per share in fiscal year t. D_p is an indicator variable that takes a value of 1 for the pth quintile, where the quintile are formed by ranking sample firms on options intensity.

	Earnings w/o B-S option expense adjustment: Ranked on option intensity	Earnings w/o B-S option expense adjustment: Ranked on lagged book-to-market	Earnings with B-S option expense adjustment: Ranked on option intensity	Earnings with B-S option expense adjustment: Ranked on lagged book-to-market
EPS _t - Portfolio 1	9.42 (10.02)	14.07 (17.77)	7.16 (7.37)	10.43 (11.04)
EPS _t - Portfolio 2	9.78 (16.20)	11.81 (21.24)	7.35 (15.49)	8.85 (15.48)
EPS _t - Portfolio 3	11.56 (13.81)	9.83 (13.59)	8.25 (9.54)	7.31 (14.71)
EPS _t - Portfolio 4	12.27 (14.45)	10.23 (8.36)	9.01 (6.48)	6.77 (6.60)
EPS _t - Portfolio 5	13.01 (10.56)	9.75 (11.55)	10.79 (7.62)	7.73 (11.83)
EPS _t * Dilution error _t	-82.45 (-2.75)	1.31 (0.06)	-119.72 (-4.64)	-55.55 (-2.71)
Adjusted R-squared (%)	60.2	61.4	44.4	45.3

t-statistics in parentheses.

FIGURE 1

Comparison of dilutive shares from options based on option value to price (price-level model), option delta (return-earnings model) and treasury stock method (FASB)

The plots are based on an underlying option with a maturity of 7 years on a stock with a price of \$100. The exercise price of the option is determined by the price-to-strike ratio. The stock's dividend yield is 1%, the annualized standard deviation of stock returns is 0.30, and the risk-free rate is 6%. The option is valued using the Black-Scholes formula for valuing European call options, as modified to account for dividend payouts by Merton (1973). The option delta is the change in this option value for a \$1 change in stock price. The treasury stock method is equal to $[(P-X)/P]$, where P is the stock price and X is the option's exercise price. SFAS No. 128 requires firms to use the treasury stock method to compute the incremental dilutive shares due to outstanding stock options.

