Employee Stock Options, Equity Valuation, and the Valuation of Option Grants Using a Warrant-Pricing Model

FENG LI* AND M. H. FRANCO WONG†

Received 5 January 2004; accepted 11 July 2004

ABSTRACT

We investigate the use of a warrant-pricing approach to incorporate employee stock options (ESOs) into equity valuation and to account for the dilutive effect of ESOs in the valuation of option grants for financial reporting purposes. Our valuation approach accounts for the jointly determined nature of ESO and shareholder values. The empirical results show that our stock price estimate exhibits lower prediction errors and higher explanatory powers for actual share price than does the traditional stock price estimate. We use our valuation approach to assess the implications of dilution on the fair-value estimates of ESO grants. We find that the fair value is overstated by 6% if we ignore the dilutive feature of ESOs. Furthermore, this bias is larger for firms that are heavy users of ESOs, small, and R&D intensive, and for firms that have a broad-based ESO compensation plan.

*University of Michigan; †University of Chicago. We thank Ray Ball, Dan Bens, Phil Berger, Clement Har, Steve Kaplan, Doron Kliger, S. P. Kothari, Susan Krische, Richard Leftwich, Thomas Lys, James Myers, Dennis Oswald, Joe Piotroski, Doug Skinner, Abbie Smith, K. R. Subramanyam, Shyam V. Sunder, Brett Trueman, Martin Wu, Peter Wysocki, an anonymous referee, and workshop participants at Chicago, MIT, Northwestern, University of Illinois at Urbana-Champaign, and the London Business School 2004 Accounting Symposium for their comments and suggestions. We gratefully acknowledge the financial support of the Graduate School of Business of the University of Chicago and the William Ladany Faculty Research Fund. We also appreciate the contribution of I/B/E/S International Inc. for providing earnings forecast data, available through the International Brokers Estimate System.

Copyright ©, University of Chicago on behalf of the Institute of Professional Accounting, 2005
1. Introduction

We investigate the use of a dilution-adjusted option-pricing model (hereafter, warrant-pricing model) to incorporate employee stock options (ESOs) into equity valuation and assess the valuation implications of dilution in estimating the fair value of ESO grants for financial reporting purposes. We treat and value ESOs like stock warrants, rather than stock options, because exercising ESOs requires a company to either issue new shares or reissue Treasury shares at below prevailing market prices. As a result, unlike exchange-traded options, both ESOs and warrants are dilutive securities.

ESOs are both prevalent and controversial. The Investor Responsibility Research Center (IRRC) reports that the potential dilution effect of ESO plans for S&P 500 companies rose from 9.2% in 1995 to 13.1% in 2000 and 13.5% in 2001 (IRRC [2002]). Furthermore, as of the end of 2001, almost all companies chose not to expense the costs associated with ESO grants in their computation of accounting earnings. Therefore, investors and shareholder advocates have expressed concerns about the economic impact of ESOs on shareholder value. It is important for shareholders and investors to take into consideration the contingent claim of existing ESOs on firm value and the operating expenses associated with future ESO grants, or they will overstate equity value.

The valuation literature has mostly ignored ESOs in equity valuation. The lack of attention to ESOs in equity valuation is partly due to the fact that the estimation of ESO value is difficult to perform in a valuation framework because the computation of ESO costs requires stock price as an input. Hence, to estimate equity value correctly, the valuation analyst needs to know the stock price, which happens to be the variable of interest. We present a valuation approach that jointly determines the values of ESOs and shareholder equity. Our approach first estimates the combined value of equity and ESOs, which we refer to as “firm equity value.” Next, we use the warrant-pricing formula to divide firm equity value between ESO holders and shareholders. We estimate firm equity value by using the residual income (RI) formulation of the discounted cash flow (DCF) model and I/B/E/S consensus earnings per share (EPS) forecasts. We discuss the adjustments that need to be made when analysts’ EPS forecasts are used in estimating firm equity value.

We evaluate the valuation approach using a panel of 357 industrial firms in the S&P 500 index from 1996 to 2001. We obtain detailed ESO data from Statement of Financial Accounting Standards (SFAS) No. 123 note disclosures. We compare the stock price estimate from our valuation approach with that produced by a traditional equity valuation method that partially

---

1 IRRC [2002] measures the potential dilution using option overhang, which is computed by dividing the sum of ESOs outstanding, plus shares reserved for future awards, by the number of common shares outstanding. According to its definition, overhang is “one way that shareholders gauge the potential dilution to their holdings from the equity being transferred to employees via stock incentive programs.”
adjusts for ESO dilution using the number of shares outstanding. The results show that our price estimate is, on average, 4% to 11.8% lower than the traditional price estimate, depending on the set of valuation assumptions chosen. Next, we compare the performance of these two share price estimates in predicting actual stock price. First, the statistics indicate that the mean absolute and squared errors of our price estimate are lower. Second, our price estimate has a higher explanatory power for actual share price than does the traditional price estimate in both univariate and multiple regressions.

Next, we apply our valuation framework to assess the valuation implications of dilution on the estimation of ESO grant value. In March 2004, the Financial Accounting Standards Board (FASB) released an exposure draft on share-based payment that would require firms to deduct the fair value of ESO grants in the computation of net income. However, neither the current nor the proposed standard addresses the dilutive feature of ESOs. A unique feature of the warrant-pricing model is that it explicitly accounts for the dilutive feature of ESOs. Thus, we can compare the fair-value estimate from a warrant-pricing formula with that from an option-pricing model to examine the valuation implications of the dilutive feature.

Nonetheless, such a comparison is complicated by the fact that the values of ESOs and options are derived from the prices of two different underlying assets. Therefore, the two fair-value estimates are comparable if and only if we estimate the intrinsic values of the underlying assets in a consistent manner. Our approach provides such a framework because we estimate both ESO and equity values from the same underlying firm equity value. Hence, both are based on a consistent set of fundamental assumptions and forecasts.

Under the assumption that security price is set according to our valuation framework, a hypothetical firm would use our stock price estimate and an option-pricing model (which ignores the dilutive effect of ESOs) to calculate the fair value of ESO grants, as required under both the existing and proposed accounting standards. We compare this option-based grant value estimate with our warrant-based, fair-value estimate of option grants and find that the option-based estimate is 6% higher than our warrant-based estimate for the median firm.

We also find systematic variation in the differences between the option-based and warrant-based estimates of the ESO grants. First, we regress the differences on the intensity of ESO usage, which we measure using the basic dilution factor (number of ESOs outstanding scaled by the number of shares and ESOs outstanding). We find that ESO intensity is significantly and positively related to the valuation difference. Hence, if we ignored the dilutive feature of ESOs in computing the fair value of ESO grants, we would find that firms that use ESOs heavily for compensation would report a larger fair-value estimate. Second, we choose the explanatory variables based on firm characteristics that are usually associated with firms that are heavy users of ESOs. We select the logarithm market value of equity, R&D intensity (R&D expense divided by sales), and a broad-based ESO usage measure
(number of executive options outstanding scaled by the number of all ESOs outstanding). We find that small firms and, in some cases, R&D-intensive firms, and firms with a broad-based ESO plan are associated with higher fair-value differences. These results are consistent with the idea that these firms are more likely to overstate ESO compensation expense if the dilutive feature of ESOs is ignored in estimating the fair value of ESO grants.

This article proceeds as follows. In section 2 we review the warrant-pricing model and present the modified version we use to incorporate ESOs into equity valuation. Section 3 discusses our estimation of the key valuation inputs. Section 4 describes the sample and summary statistics. In section 5 we report the main findings and compare the different stock price estimates with each other and with actual security price. Section 6 examines the valuation implications of dilution on estimating the fair value of ESO grants. Section 7 concludes.

2. Equity and ESO Valuations Using a Warrant-Pricing Model

We treat ESOs like stock warrants because ESOs are more similar to stock warrants than they are to stock options. Exchange-traded options are traded between two counterparties without the involvement of the company itself. But if the company is a counterparty of its ESO transactions, exercises of ESOs require the company to issue new shares or reissue Treasury shares at below-market prices. As a result, like stock warrants, ESOs can dilute the claims of the shareholders on firm value. By using a warrant-pricing approach, we explicitly account for the dilutive feature of ESOs in equity valuation and the valuation of ESO grants.

The valuation and pricing of stock warrants can be done by using a dilution-adjusted version of the Black-Scholes-Merton (BSM) model. Galai and Schneller [1978], among others, show that the value of a stock warrant that gives the holder the right to acquire a share of the underlying common stock is equal to

\[ w = \left( \frac{n}{n + m} \right) [ v N(d_1) - xe^{-rh} N(d_2) ], \]

where:

- \( w = \) value of a stock warrant;
- \( n = \) number of common shares outstanding;
- \( m = \) number of warrants outstanding;
- \( v = se^{-\delta h} + \frac{m}{n}w = \) combined values of shares and warrants;
- \( s = \) stock price;
- \( x = \) exercise price of the warrants;
- \( \delta = \) continuous dividend yield;
- \( h = \) remaining life of the warrants;
- \( r = \) risk-free interest rate;
- \( \sigma_v = \) volatility of common shares and warrants;
$N(.) = \text{cumulative standard normal distribution function};$

\[ d_1 = \frac{\ln(\frac{v}{x}) + (r + \frac{\sigma^2}{2})h}{\sigma \sqrt{h}}; \text{ and} \]
\[ d_2 = d_1 - \sigma \sqrt{h}. \]

The warrant-pricing formula (1) differs from the BSM option-pricing equation in three ways. First, the BSM formula is multiplied by $n/(n + m)$. Second, the combined value of common shares and warrants, $v$, is substituted for stock price, $s$. Third, the combined volatility of stocks and warrants, $\sigma_v$, is used instead of stock volatility. The last two adjustments recognize the fact that a warrant derives its value from the combined value of common shares and stock warrants.

In other words, equation (1) shows that the price of a stock warrant is $n/(n + m)$ times that of a call option, $c = vN(d_1) - xe^{-rh}N(d_2)$, which has the same contractual terms as the stock warrant. However, $c$ is not the value of a regular call option for the company’s stock. Instead, it is the value of a call option for an asset with a value of $v = se^{-r} + (m/n)w$. Therefore, we must compute $c$ by using the correct price and volatility for the underlying asset, as mentioned earlier. Galai and Schneller [1978], Cox and Rubinstein [1985], Lauterbach and Schultz [1990], and Hull [1993], among others, offer this interpretation of the warrant-pricing formula.

We note that the value of a stock warrant is a function of stock price, $s$, and warrant price, $w$ (both are components of $v$). If one assumes that the economic impact of stock warrants on a shareholder’s claim on equity is impounded into the stock price, $s$, one can solve for $w$ using a numerical method (Schulz and Trautmann [1994], Ukhov [2004]). However, we cannot use the warrant-pricing formula directly in equity valuation because the stock price is unknown.

2.1 USING THE WARRANT-PRICING MODEL TO VALUE ESOS AND SHAREHOLDER EQUITY

Prior research finds empirical evidence that suggests the stock market capitalizes the cost or value of ESOs into stock prices. However, ESOs are usually ignored in equity valuation research. The lack of attention paid to ESOs in equity valuation is partly due to the fact that shareholder...
and ESO values are jointly determined. Hence, a framework is needed to get shareholder and ESO value estimates that are consistent with each other.

We use the warrant-pricing formula (1) to value ESOs and incorporate them into equity valuation. Because \( s \) and \( w \) are jointly determined, we cannot estimate \( w \) without knowing \( s \), and vice versa. Furthermore, in a valuation context, the stock price is unknown. To circumvent these two problems, we instead estimate the combined value of stocks and ESOs, \( v = se^{-\delta h} + \left( \frac{m}{n} \right) w \), which we call “firm equity value” (per share of common). To avoid confusion, we use the term “firm equity value” to refer to the combined value of common stocks and ESOs, and the term “equity value” to refer to the value of common stocks alone (as it is commonly used). Next, we insert the estimated firm equity value, \( \hat{v} \), into (1) and solve for \( w \). Finally, we solve for \( s = [\hat{v} - (m/n) \hat{w}] e^{\delta h} \), given the \( v \) and \( w \) estimates from the last two steps. This is a three-step procedure to estimate ESO and shareholder equities on a per share basis. We could also conduct the estimation procedure on an aggregate basis as follows.

Given an estimate for firm equity value and the warrant-pricing formula (1), the aggregated value of all \( m \) shares of outstanding ESOs is equal to

\[
ESO = m \hat{w} = m \left( \frac{n}{n + m} \right) \hat{v} N(d_1) - m \left( \frac{n}{n + m} \right) x e^{-rh} N(d_2), \tag{2}
\]

where:

\( m \) = number of ESOs outstanding;
\( n \) = number of shares outstanding;
\( \hat{v} \) = estimate of \( v = se^{-\delta h} + \frac{m}{n} w \), the per share combined value of stocks and ESOs;
\( x \) = average per share exercise price of ESOs outstanding;
\( \delta \) = stock’s dividend yield;
\( r \) = risk-free interest rate;
\( h \) = average remaining expected life of ESOs outstanding;
\( \sigma_v \) = combined volatility of stocks and ESOs;
\( N(\cdot) \) = cumulative standard normal distribution function;
\( d_1 = \frac{\ln(\frac{x}{\hat{v}}) + (r + \frac{\sigma_v^2}{2})h}{\sigma_v \sqrt{h}} \); and
\( d_2 = d_1 - \sigma_v \sqrt{h} \).

Next, we rewrite equation (2) as follows:

\[
ESO = m \hat{w} = \left( \frac{m}{n + m} \right) n \hat{v} N(d_1) - \left( 1 - \frac{m}{n + m} \right) mx e^{-rh} N(d_2)
\]

\[
= d \hat{v} N(d_1) - (1 - d) X e^{-rh} N(d_2)
\]

\[
= \hat{S}_w N(d_1) - X_w e^{-rh} N(d_2), \tag{3}
\]
where:

\[ d = \frac{m}{n + m}, \] the so-called basic dilution factor;

\[ \hat{V} = n \times \hat{\nu}, \] estimated aggregate value of common stocks and ESOs;

\[ X = m \times x, \] aggregate proceeds from the exercises of \( m \) shares of ESOs;

\[ \hat{S}_w = d \times \hat{V}, \] estimated aggregate value of firm equity to be acquired from ESO exercises;

\[ X_w = (1 - d) \times X, \] the aggregate value of net cash paid to exercise the ESOs;

\[ d_1 = \frac{\ln \left( \frac{\hat{S}_w}{X_w} \right) + (r + \frac{\sigma^2}{2})h}{\sigma \sqrt{h}}, \] and

\[ d_2 = d_1 - \sigma \sqrt{h}. \]

Benninga and Sarig [1997] provide the following interpretation of equation (3). The exercise of all \( m \) shares of ESOs will dilute the equity claim of the existing shareholders by a factor of \( d = m/(n + m) \), the so called basic dilution factor. Given that \( \hat{V} \) is the combined value of the firm’s equity to be divided between shareholders and ESO holders, the aggregated value of the underlying firm equity value acquired by the \( m \) ESO holders will be equal to \( \hat{S}_w = d \times \hat{V} \). Furthermore, the \( m \) ESO holders need to pay a total of \( \$m \times X \) to the firm to exercise the ESOs. However, because the ESO holders will own \( d \) of the firm’s equity upon exercise, the net cash value paid by the \( m \) ESO holders is only \( X_w = m \times X \times (1 - d) \). In other words, equation (3) indicates that we can use a regular option-pricing formula to compute the dilution-adjusted value of ESOs if the inputs to the formula are dilution adjusted (i.e., if we substitute \( \hat{S}_w \) and \( X_w \) for \( S \) and \( X \), respectively).

Given the estimate of ESO value from equation (3), we use the relation among firm equity value, equity value, and ESO to solve for the per share stock price estimate as follows:

\[ \hat{V} = n \hat{\nu} = n[\hat{s}e^{-\delta h} + (m/n)\hat{\nu}], \]

or

\[ \hat{s} = \frac{(\hat{V} - m\hat{\nu})e^{\delta h}}{n} = \frac{(\hat{V} - \text{ESO})e^{\delta h}}{n}. \]

Our approach of incorporating ESOs into equity valuation is different from those discussed in Li [2002], Soffer [2000], Soffer and Soffer [2003, chap. 14], and Penman [2004, chap. 13]. First, we treat ESOs like stock

---

4 It can be shown that \( S_w/X_w = v/x \) because \( S_w = d \times n \times v \), \( X_w = (1 - d) \times m \times x \), and \( d = m/(n + m) \).

5 In reality, ESO holders do not exercise their options at the same time. Constantinides [1984] shows that (1) the optimal exercise strategy is affected by how the firms use the proceeds from warrant exercises, (2) it is not always optimal for all warrant holders to exercise, and (3) the strategic aspect of warrant exercises could affect the value of warrant. Our computation of ESO value assumes away these complications.
warrants, whereas the other researchers value ESOs as exchange-traded options. Second, we estimate firm equity value (stocks plus ESOs) and use it as input in the valuation of ESO and shareholder values, thereby circumventing the jointly determined nature of ESO and equity values. In contrast, the other researchers estimate the value of equity and subtract from it the estimated ESOs based on the estimated equity price. The only exception is Soffer [2000] and Soffer and Soffer [2003], who use an iterative process to estimate shareholder and ESO values simultaneously.

3. Estimation of Key Input Variables

In this section we describe the estimations of firm equity value, the present value of future ESO grant expenses, the volatility of firm equity value, the expected remaining life of outstanding ESOs, and the tax benefit of ESO exercises.

3.1 ESTIMATING FIRM EQUITY VALUE

Firm equity value, \( V \), is a key input in the implementation of the modified warrant-pricing formula and equity valuation approach. We estimate firm equity value using the RI formulation of the DCF model and security analysts’ forecasts of EPS. We note that the RI and DCF models are theoretically equivalent. The thrust of our article is not affected by our valuation model choice. We use the RI formulation of the DCF model because it directly links equity value estimates to analysts’ EPS forecasts, thereby simplifying the valuation procedure.

Because firm equity value is the combined value of shareholder and ESO equity, we must compute it by discounting residual earnings that accrue to both shareholders and ESO holders. However, accounting earnings and EPS do not completely capture the earnings that accrue to shareholders and ESO holders. Because security analysts forecast accounting EPS and we rely on their EPS forecasts in our estimation, we need to make two special adjustments to account for two ESO-related accounting issues.

Granting ESOs comprises two distinct transactions: the first is to sell options to employees and the second is to pay the employees immediately for their future services using the funds raised from the option sales (e.g., see Guay, Kothari, and Sloan [2003]). Although net cash flow is zero when ESOs are granted, two economic transactions take effect. The first is a financing transaction that gives ESO holders a contingent claim against the firm’s equity. The second is an operating transaction that compensates employees for their services. SFAS No. 128 (FASB [1997]) and SFAS No. 123 (FASB [1995]) deal with the financing and operating aspects of ESO transactions, respectively.

By adjusting the denominator of EPS, SFAS No. 128 and its predecessor, the Accounting Principle Board’s Opinion No. 15, account for the fact that holders of convertible securities have a contingent claim against the firm’s
earnings,\textsuperscript{6} Because the estimation of firm equity value, \( V \), requires discounting the residual earnings that accrue to both shareholders and ESO holders, we use earnings, instead of diluted EPS, forecasts in our computation.\textsuperscript{7}

Unfortunately, although I/B/E/S has sales forecasts available from 1998, earnings forecasts are only available from I/B/E/S starting in 2002. Thus, we convert I/B/E/S EPS forecasts into earnings forecasts as follows. We multiply the I/B/E/S consensus EPS forecasts by the number of shares outstanding from I/B/E/S times the diluted number of shares from Compustat divided by the number of shares outstanding from Compustat. We use this algorithm because I/B/E/S carries the number of shares outstanding but not the diluted number of shares. Because the I/B/E/S and Compustat databases are created in different months, we cannot use the diluted number of shares from Compustat to convert directly I/B/E/S EPS forecasts into earnings forecasts. Instead, we use the diluted and basic numbers of shares outstanding from Compustat to impute the adjustment factor. Finally, in converting EPS forecasts into earnings forecasts we assume that analysts are holding the diluted number of shares constant in their two- to five-year-ahead EPS forecasts.

SFAS No. 123 governs the expensing of ESO grants in the computation of operating performance. It allows firms the choice of expensing the cost of ESO grants or disclosing pro forma earnings as if they had expensed the cost of ESO grants. In fact, most firms choose not to expense ESO grants; therefore, their reported earnings are overstated. Because security analysts forecast accounting earnings (or operating income), the cost of ESO grants is also not included in their forecasts.\textsuperscript{8} As a result, using analysts’ forecasts (or mechanical forecasts based on historical earnings numbers) in valuations will overstate equity value estimates by the present value of all future ESO grant expenses (Soffer [2000]).

\textsuperscript{6} Both SFAS No. 128 and Opinion No. 15 use the Treasury stock method to account for the dilutive effect of convertible securities in computing diluted EPS and primary EPS, respectively. Diluted EPS under SFAS No. 128 is similar to primary EPS under Opinion No. 15. Under the new accounting standard, security analysts are expected to forecast diluted EPS instead of primary EPS (E. MacDonald, “It’s All in the Diluted Numbers: New Rule to Give Better Look at Effect of Options.” \textit{Wall Street Journal}, January 8, 1998, p. C1).

\textsuperscript{7} Diluted EPS is meant to capture the earnings that are accrued to shareholders. However, Core, Guay, and Kothari [2002] show that the Treasury stock method used to calculate the diluted number of shares understates the economic dilution of ESOs by almost 50% because it only accounts for the intrinsic value of the options. Hence, the use of EPS forecasts (or mechanical EPS forecasts based on historical figures) in equity valuation understates the dilutive effect of outstanding ESOs and overestimates equity value.

\textsuperscript{8} Because U.S. generally accepted accounting principles (GAAP) do not require the expensing of option grants, this assumption is a reasonable one (e.g., see “Stock Options Impact on Freight Transports,” Morgan Stanley Equity Research Report, August 28, 2003). On the other hand, the incentive effect (if any) of ESOs is reflected in historical earnings through higher sales and lower operating costs. Hence, if analysts understand the incentive effect of ESOs, they will incorporate the beneficial effect of ESOs into their EPS forecasts. In this case, the estimated firm equity value (\( V \)) would include the incentive effect of ESOs on firm value.
We correct for this problem by subtracting from the valuation the after-tax present value of future ESO grant expenses, which we call \( \text{FutESO} \). We note that this correction is not unique to our valuation approach. Any valuation approach should make the same adjustment if the operating costs associated with future ESO grants are not included in the earnings or cash flow forecasts. Forecasting and subtracting the present value of future ESO grant expenses in a valuation is similar to forecasting other future operating expenses. For example, consider an extreme case in which a firm pays for all of its expenses using ESOs and warrants. In this case, earnings and cash flow forecasts will equal sales. If we did not account for the present value of all future hidden expenses, equity value would be overstated.

By taking into consideration these two accounting issues, we implement the RI formulation of the DCF model, using a five-year forecast horizon, as follows:

\[
\begin{align*}
V_t &= \left\{ BV_t + \sum_{s=1}^{5} \frac{E_t [ R_l^{t+s} ]}{(1+k_t)^s} + \sum_{s=6}^{\infty} \frac{E_t [ R_l^{t+s} ]}{(1+k_t)^s} \right\} - (1 - \tau) \text{FutESO}_t \\
&= VF_t - (1 - \tau) \text{FutESO}_t.
\end{align*}
\]

where:

- \( V_t \) = firm equity value as of year \( t \);
- \( E_t[.] \) = expectation operator, based on information available at year \( t \);
- \( R_l = EARN_t - k_t BV_{t-1} \);
- \( EARN_t \) = earnings forecast for year \( t \);
- \( k_t \) = discount rate at year \( t \);
- \( BV_t \) = book value forecast for year \( t \);
- \( \tau \) = marginal tax rate;
- \( \text{FutESO}_t \) = present value of future ESO grant expenses (discussed in section 3.1.1); and
- \( VF_t \) = \( \left\{ BV_t + \sum_{s=1}^{5} \frac{E_t [ R_l^{t+s} ]}{(1+k_t)^s} + \sum_{s=6}^{\infty} \frac{E_t [ R_l^{t+s} ]}{(1+k_t)^s} \right\} \) = firm equity value before the after-tax present value of future ESO grants.

For most sample firms, we have I/B/E/S consensus EPS forecasts only for FY1 and FY2, and the long-term growth (LTG) forecast. In these cases, we extrapolate the missing FY3, FY4, and FY5 forecasts by using the LTG forecast. Thus, we require the FY2 forecast to be positive for those cases, or we delete the entire observation. We convert the EPS forecasts into earnings forecasts as discussed earlier. We estimate the future book values of equity (\( BV_t \)) using the clean surplus relation, which links future book values to current book values, expected earnings, and expected dividends. We do not adjust the book value for ESOs because we assume the ex ante clean surplus relation holds. Hence, we calculate the resulting RI valuation as if there were no ESOs outstanding and no future ESO grants. The dilution of
existing ESOs and the operating expenses associated with future ESO grants are accounted for using the valuation approach in this article.

We compute expected dividends by using the payout ratio, which is equal to current cash dividends divided by the FY1 earnings forecast. If the FY1 forecast is nonpositive, we use the normal earnings level imputed with a 12% return on equity (ROE). We bound the payout ratio between 0.1 and 0.5 to mitigate extreme values. We estimate the discount rate as the 10-year Treasury bond yield plus the firm’s stock beta times a 5% market risk premium. Changing the market risk premium to 3% or 7% does not affect the qualitative findings.

We calculate the terminal value (the last term inside the curly brackets) using two methods. First, we follow Liu and Thomas [2000] and compute the terminal value using the five-year-out value-to-book ratio. Writing out $V_{t+5}$ for $V_{t+4}$ shows that the terminal term is equal to $V_{t+5} - B_{t+5}$. If we assume that the five-year-out $V$-to-book ratio remains constant in years $t-1$ and $t$ (i.e., $E_{t-1}[V_{t+4}/B_{t+4}] = E_t[V_{t+5}/B_{t+5}]$), we obtain the five-year-out $V$-to-book premium as follows:

$$E_t[V_{t+5} - B_{t+5}] = E_t[B_{t+5}] \times (E_t[(V_{t+5}/B_{t+5})] - 1)$$

where we can calculate

$$E_{t-1}[V_{t+4}/B_{t+4}] = \left\{ \frac{\sum_{s=1}^{5} E_{t-1}[RI_{t+s-1}]}{(1 + k_{t-1})^5} \right\} \times \left\{ \frac{(1 + k_{t-1})^5}{E_{t-1}[B_{t+4}] + 1} \right\}$$

based on data available at $t-1$. Using equations (4) and (5), we can show that $V_{t+1} = S_{t-1}e^{-\delta h} + ESO_{t-1} + (1 - \tau)FutESO_{t-1}$. We use the stock price at time $t-1$ to calculate the three components on the right-hand side of this expression. The Liu and Thomas approach allows the growth rates for residual income to vary across firms and over time beyond the forecast horizon. We use this method to capture the fact that financial analysts are likely to have more specific information about a firm’s terminal growth rate, given firm- and time-specific information. We label the firm equity value estimated under this assumption $V_{(VB5)}$.

Second, as an alternative, we follow Kaplan and Ruback [1995] and Francis, Olsson, and Oswald [2000] and assume that the growth rate in residual income stays at 4% forever after the terminal year. We call the firm equity value computed under this terminal value assumption $V_{(4\%g)}$.

3.1.1. Estimating the Present Value of Future ESO Grant Expenses. To estimate the present value of future ESO grant expenses, we assume that the value of current ESO grants ($G_t$) grows at a rate of $g$ for the next $n$ years and that the growth rate stays at $gT$ forever afterward. We discount the stream of future grants using $k_t$, the same discount rate we use in the computation of firm
equity value. Hence, the present value of the operating expenses associated with future grants \( \text{FutESO}_t \) is equal to

\[
\text{FutESO}_t = \frac{G_t(1 + g)}{1 + k_t} + \cdots + \frac{G_t(1 + g)^n}{(1 + k_t)^n} + \frac{G_t(1 + g)^n(1 + gT)}{(k_t - gT)(1 + k_t)^n} = G_t \times \text{DFAC},
\]

(7)

where

\[
\text{DFAC} = \left[ \frac{1}{1 + k_t} + \cdots + \frac{(1 + g)^n}{(1 + k_t)^n} + \frac{(1 + g)^n(1 + gT)}{(k_t - gT)(1 + k_t)^n} \right].
\]

Next, we use the warrant-pricing formula in equation (3) to estimate the value of current grants, \( G_t \), in equation (7) as follows:

\[
\text{FutESO}_t = \left[ S_G N(d_1) - X_G e^{-r_h} N(d_2) \right] \times \text{DFAC}
\]

\[
= \left\{ d_G \times \left[ VF_t - (1 - \tau) \times \text{FutESO}_t \right] N(d_1) - X_G e^{-r_h} N(d_2) \right\} \times \text{DFAC},
\]

(8)

where:

- \( S_G = d_G \times [VF - (1 - \tau) \times \text{FutESO}] \);
- \( d_G = m_G / (m_G + m + n) \);
- \( m_G = \) number of ESOs newly granted;
- \( m = \) number of ESOs outstanding;
- \( n = \) number of shares outstanding;
- \( VF = \) firm equity value before value of future ESO grants (see equation (5));
- \( \tau = \) marginal tax rate;
- \( X_G = m_G \times X \times (1 - d_G) \);
- \( X = \) per share exercise price of newly granted ESOs;
- \( h = \) expected life of newly granted ESOs;
- \( \delta = \) stock’s dividend yield;
- \( r = \) risk-free interest rate;
- \( N(.) = \) cumulative probability distribution function for a unit normal random variable with zero mean;
- \( d_1 = \frac{\ln \left( \frac{S_G}{X_G} \right) + (r + \frac{\sigma^2}{2})h}{\sigma \sqrt{h}} \);
- \( d_2 = d_1 - \sigma \sqrt{h} \); and
- \( \sigma_v = \) volatility of common shares and ESOs.

Computing the value of \( \text{FutESO}_t \) in equation (8) is complicated by the fact that \( \text{FutESO}_t \) is also a function of \( \text{FutESO}_t \). To solve for \( \text{FutESO}_t \), we assume that \( d_1 \) and \( d_2 \) are independent of \( S_G \) and \( X_G \), which is the case if \( S_G = X_G \) (i.e., if the options are granted at the money). Under this assumption, we can rearrange terms and solve for \( \text{FutESO}_t \) as follows:

\[
\text{FutESO}_t = \frac{\left[ d_G \times VF_t N(d_1) - X_G e^{-r_h} N(d_2) \right] \times \text{DFAC}}{1 + (1 - \tau) \times d_G \times N(d_1) \times \text{DFAC}}.
\]

(9)
In our empirical analysis, we compute $FutESO_t$ using two sets of assumptions. First, we assume that future grant expenses will grow at the same rate as the I/B/E/S long-term EPS growth rate for the next five years and then stay at 3% forever afterward (i.e., $g = LTG; \ n = 5; \ g_T = 3\%$). We label this the “decaying growth” assumption. Second, we assume that future grant expenses will grow at 3% forever (i.e., $g = 3\%; \ n = 5; \ g_T = 3\%$). We call this the “constant growth” assumption.

Although we assume that future grant expenses will grow at a certain rate, one can argue that they might drop because the financial reporting benefit of using ESOs might disappear once firms are required to expense ESO costs. We base our assumption on the rationale that employees require a certain level of total compensation in exchange for their services. Therefore, even if firms plan to discontinue or reduce future ESO grants, they will have to replace them with other forms of compensation, such as stock grants, restricted stocks, bonuses, or cash. In that case, the estimated present value of future ESO grant expenses captures all of these compensation expenses. In other words, we assume that all compensation costs are operating expenses regardless of the form of payment (e.g., cash, bond, stock, or option).

We subtract the present value of future ESO grant expenses in the estimation of firm equity value (in equation (5)) because those expenses constitute operating expenses that are ignored in analysts’ earnings and EPS forecasts. Otherwise, equity value will be overstated (Soffer [2000], Penman [2004]). If the fair value of ESO grants is required to be deducted from earnings, as proposed in the exposure draft (FASB [2004]), and security analysts subtract ESO expenses in their forecasts as a result, there will be no need to account for $FutESO$ in equation (5) and $V_t = V_F^t$.10

However, if one believes that the reported ESO expense measures the true economic cost with error, one can back out the ESO expense from analysts’ forecasts, estimate the cost of future ESO grants separately, and follow the procedure we describe in this section to compute firm equity value. There are at least two reasons why one might want to make such an adjustment. First, one might not agree with the FASB’s requirement of amortizing ESO costs over the vesting period. Second, one might not agree with the model or assumptions used by the reporting firm in estimating the fair value of ESO grants.

---

9 For example, Microsoft announced in the summer of 2003 that it would phase out ESOs and replace them with restricted stock. In October 2003, Oracle also announced that it would substitute other equity incentives (to be determined) for ESOs. However, it is unclear whether the level of total compensation will remain the same for these and other companies (see “Options Grow Onerous: Expensing Is Forcing Companies to Rethink Employee Pay Perks,” Business Week, December 1, 2003, pp. 36, 37).

10 In fact, between July 2002 and March 2003, 155 firms announced their intention to expense the cost of ESO grants (Aboody, Barth, and Kasnik [2004]). Hence, if analysts start including ESO expenses in their earnings forecasts from that date onward (e.g., see “Stock Options Impact on Freight Transports,” Morgan Stanley Equity Research Report, August 28, 2003), one should set $FutESO_t$ to zero in equation (5) for these firms. During our sample period, 1996–2001, only Boeing and Winn-Dixie deducted ESO grant costs from their earnings.
3.2 ESTIMATING VOLATILITY

The warrant-pricing model requires the volatility of firm equity value (stocks and ESOs), $\sigma_v$, as an input. We can compute this volatility as the weighted average of the volatility of the return on the stock and the return on the ESOs, weighted by the proportional values of stocks and ESOs. In general, the volatility of ESO return is only slightly higher than that of stock return (Benninga and Sarig [1997]), and ESO value is usually a small fraction of the equity value. For these two reasons, the weighted average of the stock and ESO volatilities will be very close to the stock volatility. Hence, we use the stock volatility disclosed in the SFAS No. 123 footnote to measure the volatility of firm equity value.

3.3 ESTIMATING THE EXPECTED REMAINING LIFE OF ESOs

In computing the valuation of ESOs, we use the expected remaining life of the ESOs. We do so because Hemmer, Matsunaga, and Shevlin [1994] show that in the computation of ESO value one can take into account the early exercise of ESOs by using the expected life, rather than the contractual life, of the ESOs. In fact, Marquardt [2002] shows that such an adjustment reduces the upward bias of the BSM model for ESO valuation. We adopt this adjustment in our computation. We compute the remaining expected life, $h$, as the expected life of newly granted options minus the difference between the contractual life and the remaining contractual life of options outstanding. We restrict the estimated remaining expected life to be no less than six months.

3.4 ESTIMATING THE TAX BENEFIT OF ESO EXERCISES

Firms can deduct the intrinsic value of nonqualifying ESOs exercised as a tax-deductible expense, thereby lowering their after-tax ESO costs. To obtain the after-tax ESO cost to the firm, we multiply the ESO estimate in equation (3) by $(1 - \tau)$, where $\tau$ is the marginal tax rate.

We prove this linear tax adjustment by using the binomial option pricing approach and a no-arbitrage argument. Consider two ESOs, A and B, that are identical, except that A is tax deductible for the issuing company. The current time is time 0. Because the firm’s tax deductibility of the ESOs does not affect the exercise decision of the employee, he or she will exercise both ESOs at the same time, $T_e$. The payouts (i.e., intrinsic values) of these two ESOs are equal at each end node at time $T_e$. However, the after-tax cost of A is lower for the issuing firm by a factor of $(1 - \tau)$. Because the after-tax cost of A is always $(1 - \tau)$ times that of B for each node at time $T_e$, the cost of A must be $(1 - \tau)$ that of B at time 0. Suppose this is not true and A costs more than $(1 - \tau)$ times B, then one can enter into a position that shorts $1/(1 - \tau)$ share of A and longs 1 share of B. This position creates a positive cash inflow at time 0, but zero net cash flow at time $T_e$. Because the no-arbitrage assumption is violated, the cost of A cannot be higher than $(1 - \tau)$ times that of B at time 0. The converse is also true. Hence, the cost of A must be $(1 - \tau)$ times that of B at time 0.
We follow Graham’s [1996a, b] suggestion to use the historical effective tax rate for the marginal tax rate. We calculate the historical rate as the average effective tax rate over the past three years. Untabulated results indicate that using the one-year lagged effective tax rate generates qualitatively similar results. However, this simple tax adjustment is not likely to account fully for the complex tax effects of ESOs, as discussed in Hanlon and Shevlin [2002].

4. Sample and Descriptive Statistics

4.1 Sample Selection and Data

Our sample is based on 357 Compustat firms in the S&P 500 industrial index, which excludes utilities, financial, and transportation firms. The sample period covers the six fiscal years 1996 through 2001. We start with 1996 because it is the first year in which SFAS No. 123 became effective and required detailed disclosures of ESO information. We end in 2001 because it is the last year for which the most recent data are available.

We obtain ESO data from SFAS No. 123 note disclosures for each of the fiscal years 1996 through 2001. The appendix uses the 1996 10-K report of The Gap Inc. (for the year ended February 1, 1997) to illustrate these disclosures. The first table in the Gap disclosure presents the numbers and weighted-average exercise prices of the ESOs granted, exercised, canceled, and outstanding during the last three years. The last table in the Gap example provides detailed information for the ESOs outstanding at the end of the fiscal year by exercise price. We note that most of our data come from this table. Because the information in this table is reported only for the most recent fiscal year, we collect the data from the 10-Ks for each of the six sample years 1996 to 2001. For each ESO layer, the table gives the number of ESOs outstanding, the weighted-average remaining contractual life, and the weighted-average exercise price. The table also gives the number of ESOs that are exercisable and the corresponding weighted-average exercise price. However, the average remaining contractual life of the exercisable ESOs is not a required disclosure item.

We also use data related to the parameters of the newly granted ESOs disclosed by the firms. Given these data, we first value each layer of ESOs outstanding using the risk-free interest rate, dividend yield, stock volatility, and expected life for the recently granted ESOs. We then sum the ESO estimates across layers to obtain the total ESO value estimate.

We obtain data on consensus EPS forecasts from I/B/E/S; stock beta, price, and return data from the Center for Research in Security Prices (CRSP); and other financial statement data are from Compustat. We adjust all share and price data for stock splits. In general, if a stock split occurs after the fiscal year’s end but before the release of the financial statement, the firm will provide split-adjusted price and share data in its 10-K. To match the numbers we collect from the 10-K with those retrieved from Compustat and CRSP, we undo the split adjustments made on the financial statement.
The sample consists of 357 firms in the S&P 500 industrial index (which excludes utilities, financial institutions, and transportation firms). To be included in the final sample, a firm-year observation must have employee stock option (ESO) data from SFAS No. 123 note disclosures, required financial statement data from Compustat, consensus earnings forecasts from I/B/E/S, and stock price and return data from the Center for Research in Security Prices (CRSP). We adjust all share and price data for stock splits and stock dividends. We provide descriptive statistics for 1,937 firm-year observations, covering the six fiscal years 1996–2001. We compute the market value of equity by using the closing stock price three months after the fiscal year end times the number of shares outstanding. We measure the book value of equity as of the end of the fiscal year. \( R&D/Sales \) is the R&D expenses for the year, scaled by net sales for the year. We set \( R&D/Sales \) to zero if the R&D expense is missing. The number of ESO layers is the number of detailed ESO data disclosed by exercise price. The basic dilution factor is the number of ESOs outstanding divided by the sum of the number of ESOs outstanding and the number of shares outstanding. The remaining life is the weighted average of remaining contractual life, as disclosed by the firms. The expected remaining life is the weighted average of expected life remaining, which we compute as the expected life of newly granted options minus the difference between the contractual life and the remaining contractual life of options outstanding. We bound the expected remaining life estimate from below at 0.5. ESO exercisable/outstanding is the number of options exercisable divided by the total number of options outstanding.

Data and use the ratio of the number of shares outstanding reported in the financial statements to the corresponding number retrieved from Compustat.

4.2 DESCRIPTIVE STATISTICS

Table 1, panel A provides summary statistics for the sample firms. The market value of equity averages $19.9 billion, with a median of $6.7 billion. In contrast, the book value of equity only averages $4 billion. The average (median) firm spends about 4% (1%) of net sales on R&D.

Panel B in table 1 reports statistics for the ESO portfolios. The sample firms provide an average of about 4 layers of detailed ESO information (e.g., as The Gap Inc. did in 1996). There is only 1 layer of information at the first percentile, but 10 layers at the 99th percentile. HCA Healthcare reports the maximum number of layers, 24, in 2001. The mean (median) number of ESOs outstanding is 45 (14.4) million shares and the average
The (median) basic dilution factor is 7.4% (6.6%). The top 1% of firms has a basic dilution of at least 22.2%. In other words, if ESO holders were to exercise all outstanding ESOs, they would own 22.2 of the common shares then outstanding. The companies in the top 1% include 3Com, AOL, Broadcom, Donnelley (R.R.) & Sons, LSI Logic, Maxim Integrated Products, Nortel Networks, Qualcomm, and Siebel Systems. Broadcom reported the maximum basic dilution factor of 36.3% in 1999.

Both the mean and median weighted-average remaining contractual life is 7 years. Our estimate of the remaining expected life averages 3.8 years. The weighted-average exercise price of all outstanding ESOs averages about 83% of the average stock price for the year, or 95% at the 75th percentile. The average number of ESOs exercisable (vested) is 21 million shares. Both the mean and median percentages of exercisable ESOs are about 49% of all ESOs outstanding, ranging from 9.8% to 90.7%. On average, the weighted-average exercise price for the exercisable ESOs is 73% of the average stock price, which is lower than the corresponding figure for the entire ESO portfolio (i.e., the exercisable ESOs are deeper in the money, on average).

Table 2, panel A presents statistics for the valuation parameters for newly granted ESOs, as disclosed by the sample firms. The average risk-free interest rate, dividend yield, stock volatility, and expected life used are 5.7%, 1.4%, 34.8%, and 5.4 years, respectively. These are the parameters the sample firms use to compute the fair value of ESOs granted during the year, as required by SFAS No. 123.

Panel B in table 2 shows statistics for the key variables used to estimate firm equity value. We find that the mean stock beta is close to one, but the range varies widely. The firms with high stock betas are in the

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>1%</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>99%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: ESO parameters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk-free interest rate (%)</td>
<td>5.7</td>
<td>0.7</td>
<td>5.9</td>
<td>5.2</td>
<td>5.8</td>
<td>6.2</td>
<td>7.0</td>
</tr>
<tr>
<td>Dividend yield (%)</td>
<td>1.4</td>
<td>1.4</td>
<td>0.0</td>
<td>1.1</td>
<td>2.2</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>Stock volatility (%)</td>
<td>34.8</td>
<td>15.9</td>
<td>14.5</td>
<td>24.1</td>
<td>30.3</td>
<td>40.5</td>
<td>83.9</td>
</tr>
<tr>
<td>Expected life (years)</td>
<td>5.4</td>
<td>1.5</td>
<td>2.0</td>
<td>4.5</td>
<td>5.0</td>
<td>6.0</td>
<td>10.0</td>
</tr>
<tr>
<td><strong>Panel B: Valuation parameters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stock beta</td>
<td>1.00</td>
<td>0.48</td>
<td>0.04</td>
<td>0.68</td>
<td>0.95</td>
<td>1.26</td>
<td>2.37</td>
</tr>
<tr>
<td>Discount rate (%)</td>
<td>10.6</td>
<td>2.5</td>
<td>5.6</td>
<td>9.0</td>
<td>10.4</td>
<td>12.1</td>
<td>17.6</td>
</tr>
<tr>
<td>Long-term growth rate (%)</td>
<td>15.8</td>
<td>8.2</td>
<td>6.3</td>
<td>11.1</td>
<td>13.9</td>
<td>18.2</td>
<td>47.4</td>
</tr>
<tr>
<td>Historical effective tax rate (%)</td>
<td>34.4</td>
<td>10.8</td>
<td>3.7</td>
<td>35.8</td>
<td>35.8</td>
<td>39.1</td>
<td>65.0</td>
</tr>
<tr>
<td>Lagged effective tax rate (%)</td>
<td>33.8</td>
<td>12.8</td>
<td>0.0</td>
<td>31.0</td>
<td>36.0</td>
<td>39.1</td>
<td>65.0</td>
</tr>
</tbody>
</table>

The sample consists of 357 firms in the S&P 500 industrial index from 1996 to 2001. We present descriptive statistics for 1,937 firm-year observations that do not have missing values for key variables. The risk-free interest rate, dividend yield, stock volatility, and expected life are the option parameters used by the sample firms to compute the fair value of newly granted options. We compute the discount rate as the 10-year Treasury bond yields plus the firm’s stock beta times a 5% market risk premium. The long-term growth rate is the I/B/E/S median annual increase in earnings per share over the next three to five years. The historical effective tax rate is the average of the effective tax rates from the past three years. The lagged effective tax rate is the prior year’s effective rate.
high-technology industries. The discount rate we estimate by using a 5% market risk premium averages 10.6%, with a range between 5.6% and 17.6%. The I/B/E/S consensus LTG rate is 15.8% on average, and it is 47.4% at the 99th percentile (AOL, Broadcom, MedImmune, Network Appliance, Qwest Communications, Sapient, Siebel Systems, Veritas Software, and Yahoo are among the firms in the top 1%). The mean (median) three-year average historical effective tax rate is 34.4% (35.8%), and the mean (median) lagged effective tax rate is 33.8% (36.0%).

5. Valuation Results

5.1 VALUE ESTIMATES

Table 3 reports summary statistics for the estimated firm equity value, existing ESOs, and the present value of future grant expenses. We report four sets of results because the estimations are sensitive to the choice of the valuation assumption. Panel A uses the Liu and Thomas [2000] approach to estimate the terminal value as described in equation (6). Panel B adopts the 4% terminal growth rate assumption. These are labeled $V_{(VB5)}$ and $V_{(4\%g)}$, respectively, in the table. In each panel, we also report two sets of results based on different assumptions on future grant expenses: decaying growth (assuming option grant expenses grow for five years at the I/B/E/S LTG rate and 3% forever afterward) and constant growth (assuming a constant 3% growth rate forever). The constant growth assumption is more conservative than the decaying growth counterpart because the I/B/E/S LTG rates were very high during our sample period (see table 2). To the extent that the growth forecasts are biased upward, the validity of our results will be affected.

Panel A shows that firm equity value, $V$, averages $20.91$ billion, with a median of $6.14$ billion, under the constant growth assumption for future grant expenses. The median after-tax values of future grant expenses, $FutESO$, and outstanding ESOs, $ESO$, are $354$ million and $94$ million, respectively, under the constant growth grant expense assumption. We find that the corresponding number for $FutESO$ is higher ($547$ million) under the decaying growth assumption. On the other hand, both $V$ and $ESO$ are lower because a higher grant expense lowers $V$ and, therefore, $ESO$. Panel B indicates that when we calculate the firm equity values using the 4% terminal growth assumption, the value estimates are lower than those reported in panel A. For instance, when we assume that future grant expenses will grow at a constant rate, we find that the average $V_{(4\%g)}$ is $12.99$ billion, compared with an average $V_{(VB5)}$ of $20.91$ billion.

To get a sense of the importance of outstanding ESOs and future ESO grant expenses, we scale after-tax $ESO$ by $V$ and after-tax $FutESO$ by $V$: The mean estimated after-tax value of all outstanding ESOs is about 2.1% of $V_{(VB5)}$ in panel A, and about 1.5% of $V_{(4\%g)}$ in panel B. Both figures
Descriptive Statistics on Estimated Firm Equity Value, Existing Stock Options, and Future Grant Expenses

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev.</th>
<th>Q3–Q1</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev.</th>
<th>Q3–Q1</th>
</tr>
</thead>
<tbody>
<tr>
<td>(V) ($MM)</td>
<td>1,937</td>
<td>19,964</td>
<td>5,864</td>
<td>12,101</td>
<td>21,099</td>
<td>6,135</td>
<td>54,140</td>
<td>12,700</td>
<td></td>
</tr>
<tr>
<td>(VF) ($MM)</td>
<td>1,937</td>
<td>21,108</td>
<td>6,575</td>
<td>44,616</td>
<td>13,499</td>
<td>21,108</td>
<td>6,575</td>
<td>44,616</td>
<td>13,499</td>
</tr>
<tr>
<td>((1 - \tau)) \times FutESO ($MM)</td>
<td>1,937</td>
<td>201</td>
<td>87</td>
<td>236</td>
<td>459</td>
<td>94</td>
<td>1,435</td>
<td>260</td>
<td></td>
</tr>
<tr>
<td>((1 - \tau)) \times ESO ($MM)</td>
<td>1,937</td>
<td>10.9%</td>
<td>7.6%</td>
<td>10.2%</td>
<td>9.9%</td>
<td>6.9%</td>
<td>5.1%</td>
<td>6.0%</td>
<td>6.1%</td>
</tr>
<tr>
<td>((1 - \tau)) \times FutESO/(VF)</td>
<td>1,937</td>
<td>2.0%</td>
<td>1.4%</td>
<td>1.9%</td>
<td>1.7%</td>
<td>2.1%</td>
<td>1.5%</td>
<td>2.0%</td>
<td>1.8%</td>
</tr>
</tbody>
</table>

Panel B: \(V(4\%g)\)

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev.</th>
<th>Q3–Q1</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev.</th>
<th>Q3–Q1</th>
</tr>
</thead>
<tbody>
<tr>
<td>(V) ($MM)</td>
<td>1,798</td>
<td>12,575</td>
<td>4,295</td>
<td>26,920</td>
<td>8,213</td>
<td>12,994</td>
<td>4,432</td>
<td>27,719</td>
<td>8,613</td>
</tr>
<tr>
<td>(VF) ($MM)</td>
<td>1,798</td>
<td>13,340</td>
<td>4,728</td>
<td>25,931</td>
<td>9,246</td>
<td>13,340</td>
<td>4,728</td>
<td>25,931</td>
<td>9,246</td>
</tr>
<tr>
<td>((1 - \tau)) \times FutESO ($MM)</td>
<td>1,798</td>
<td>165</td>
<td>44</td>
<td>440</td>
<td>98</td>
<td>184</td>
<td>48</td>
<td>483</td>
<td>110</td>
</tr>
<tr>
<td>((1 - \tau)) \times ESO ($MM)</td>
<td>1,798</td>
<td>9.6%</td>
<td>6.6%</td>
<td>9.8%</td>
<td>9.3%</td>
<td>6.1%</td>
<td>4.3%</td>
<td>6.1%</td>
<td>5.9%</td>
</tr>
<tr>
<td>((1 - \tau)) \times FutESO/(VF)</td>
<td>1,798</td>
<td>1.4%</td>
<td>1.0%</td>
<td>1.4%</td>
<td>1.4%</td>
<td>1.5%</td>
<td>1.0%</td>
<td>1.6%</td>
<td>1.5%</td>
</tr>
</tbody>
</table>

The sample consists of 357 firms in the S&P 500 industrial index from 1996 to 2001. \(V\) is firm equity value, which we compute using the residual income model and analyst earnings forecasts (see equation (5)). \(VF\) is firm equity value before the after-tax present value of future employee stock option (ESO) grants (see equation (5)). \(FutESO\) is the present value of future grant expenses. \(ESO\) is the value of existing ESOs, which we calculate using \(V\) and the modified warrant-pricing approach (see equation (3)). \(\tau\) is the marginal tax rate, calculated as the average effective tax rate from the past three years. In calculating \(V\) and \(VF\), we use two different terminal value computations. In panel A, we estimate the terminal value using the five-year-out value-to-book (\(VB5\)) technique given in equation (6). In panel B, we estimate the terminal value by assuming a constant 4% terminal growth rate \((4\%g)\). In calculating \(FutESO\), we consider two assumptions on the growth of future ESO grant expenses. Under the decaying growth assumption, we assume future grant expenses grow at the I/B/E/S long-term growth rate forecast for five years and at 3% forever thereafter. Under the constant growth assumption, we assume future grant expenses grow at 3% forever.

are much smaller than the average basic dilution factor of 7.4% reported in table 1. These results suggest that the basic dilution factor is not a good indicator of the economic dilution of ESOs. Results not tabulated show that at the high end, the average value of existing ESOs is about 5% for several high-tech companies, including Altera, Analog Devices, AOL, Dell, Linear Technology, Maxim Integrated Products, Microsoft, Qualcomm, and Xilinx. Moreover, the mean estimated after-tax present value of future grant expenses \((FutESO)\) ranges from 6.1% to 10.9% of \(VF\). The present value of future grant expenses is smaller (almost by 50%) under the constant grant growth assumption than under the decaying growth assumption. In sum, the results in table 3 suggest that ignoring existing ESOs, and especially future grant expenses, could materially overstate equity value estimates.
5.2 SHARE PRICE ESTIMATES

We compare two stock price estimates that we calculate from the value estimates discussed earlier. We define the price estimates as follows:

\[
EPRC_t = \frac{[V_t - (1 - \tau) \times ESO_t]}{\text{Number of Common Shares}_t} e^{\delta h} \tag{10}
\]

and

\[
DPRC_t = \frac{VF_t}{\text{Diluted Number of Shares}}. \tag{11}
\]

\(EPRC\) is our ESO-adjusted stock price estimate, which we derive from the valuation approach developed in equation (4). \(DPRC\) is the corresponding share price estimate commonly used in practice and in the valuation literature. In the numerator, \(DPRC\) ignores the valuation implications of ESOs outstanding and future option grant expenses, but in the denominator \(DPRC\) adjusts for the dilution effect by using the diluted number of shares outstanding. Core, Guay, and Kothari [2002] show that the Treasury stock method understates the economic dilution of ESOs on EPS by almost 50%. Therefore, we believe that using the diluted number of shares to account for the dilutive effect of ESOs in share price estimate will not completely account for the dilutive effect of ESOs. We investigate which stock price estimate does better in accounting for the valuation implications of ESOs by comparing their predicting power for actual share price.

Table 4 compares the two price estimates, \(EPRC\) and \(DPRC\). When we calculate price estimates under the constant grant growth assumption, the results show that \(DPRC\) is statistically larger than \(EPRC\) by 5.38% in panel A and 4.03% in panel B. Furthermore, at least 50.48% of the \(DPRC\) estimates are higher than the corresponding \(EPRC\) estimates. The mean absolute differences between \(EPRC\) and \(DPRC\) are more than 12% of \(EPRC\). Under the constant growth assumption for future grant expenses, the mean squared differences between \(EPRC\) and \(DPRC\) are slightly less than 6%. The two price estimates are within 15% of each other for about 67% to 79% of the firm-year observations.

In table 5 we compare and contrast the prediction errors of \(EPRC\) and \(DPRC\) for actual stock price. Following Penman and Sougiannis [1998], Francis, Olsson, and Oswald [2000], and Kaplan and Ruback [1995], we show the signed prediction error (bias), absolute error (accuracy), squared error, and the percentage of estimates within 15% of the stock price (central tendency). The prediction errors using the VB5 terminal value assumption (panel A) are always smaller than those based on the 4% growth rate assumption (panel B). This finding suggests that imposing a constant terminal growth rate (panel B) might lead to a noisier valuation than would allowing the terminal growth rate to vary across firms and over time (panel A).

When we look at the predicting power of the two share price estimates in panel A (using VB5 for terminal value), we find that, on average, \(EPRC\)
Table 4

Difference between ESO-Adjusted Price Estimate (EPRC) and Traditional Price Estimates (DPRC)

<table>
<thead>
<tr>
<th>Growth Assumption for Future ESO Grant Expenses</th>
<th>Decaying Growth</th>
<th>Constant Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DPRC versus EPRC</td>
<td>DPRC versus EPRC</td>
</tr>
<tr>
<td><strong>Panel A: ( V(VB5) )</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean signed difference</td>
<td>11.76% ((t = 15.96))</td>
<td>5.38% ((t = 9.82))</td>
</tr>
<tr>
<td>Percent positive</td>
<td>63.10%</td>
<td>56.14%</td>
</tr>
<tr>
<td>Mean absolute difference</td>
<td>18.52%</td>
<td>13.23%</td>
</tr>
<tr>
<td>Mean squared difference</td>
<td>11.68%</td>
<td>5.99%</td>
</tr>
<tr>
<td>Percentage within 15%</td>
<td>66.95%</td>
<td>75.65%</td>
</tr>
<tr>
<td>( N )</td>
<td>1,897</td>
<td>1,897</td>
</tr>
</tbody>
</table>

| **Panel B: \( V(4\%g) \)**                     |                |                |
| Mean signed difference                          | 9.75% \((t = 13.21)\) | 4.03% \((t = 7.14)\) |
| Percent positive                                | 58.87%          | 50.48%          |
| Mean absolute difference                        | 16.78%          | 12.17%          |
| Mean squared difference                         | 10.57%          | 5.78%           |
| Percentage within 15%                           | 71.05%          | 78.92%          |
| \( N \)                                        | 1,765           | 1,765           |

The table reports descriptive statistics for the differences between stock price estimates for a sample of 357 S&P 500 industrial firms. The share prices are computed as follows: 

\[
EPRC_t = \frac{[V_t - (1 - \tau) \times ESO_t]e^{\delta_h}}{\text{Number of Common Shares}}, \quad \text{and} \quad DPRC_t = \frac{VF_t}{\text{Diluted Number of Shares}},
\]

\( V \) is firm equity value, which we compute using the residual income model and analysts’ earnings forecasts (see equation (5)). \( VF \) is the firm equity value before the after-tax present value of future employee stock option (ESO) grants (see equation (5)). \( FutESO \) is the present value of future grant expenses (see equation (9)). \( ESO \) is the value of existing ESOs, which we calculate using \( V \) and the modified warrant-pricing approach (see equation (3)). \( \tau \) is the marginal tax rate, calculated as the average effective tax rate in the past three years. In calculating \( V \) and \( VF \), we use two different terminal value computations. In panel A, we estimate the terminal value using the five-year-out value-to-book (\( VB5 \)) technique given in equation (6). In panel B, we estimate the terminal value by assuming a constant 4% terminal growth rate (\( 4\%g \)). In calculating \( FutESO \), we consider two assumptions on the growth of future ESO grant expenses. Under the decaying growth assumption, we assume future grant expenses grow at the I/B/E/S long-term growth rate forecast for five years and at 3% forever thereafter. Under the constant growth assumption, we assume future grant expenses grow at 3% forever.

has a smaller bias (signed prediction errors) than does \( DPRC \). In contrast, panel B indicates that under the two different future grant assumptions, \( EPRC \) has average mean signed errors of \(-19.89\% \) and \(-16.29\% \), and that both are more negative than that of \( DPRC \) \((-12.56\%) \). However, the other three statistics reported in the table clearly show that \( EPRC \) is better than \( DPRC \) in predicting actual share price. Under different terminal value and future grant assumptions, the mean absolute prediction errors and the mean squared errors of \( EPRC \) are consistently lower than those of \( DPRC \). For instance, panel A shows that under the constant growth assumption for future grants, the mean squared prediction error of \( EPRC \) is 18.33%, but that of \( DPRC \) is close to 33.89%. The central tendency of \( EPRC \) is also slightly better than that of \( DPRC \) under all four combinations of valuation assumptions. We add to the Core, Guay, and Kothari [2002] findings by showing that the use of diluted EPS in valuation overstates
## Table 5

<table>
<thead>
<tr>
<th>Growth Assumption for Future ESO Grant Expenses</th>
<th>DPRC</th>
<th>EPRC</th>
<th>EPRC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Decaying Growth</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean signed error (bias)</td>
<td>9.40%</td>
<td>-1.13%</td>
<td>3.41%</td>
</tr>
<tr>
<td>( t = 7.12 )</td>
<td>( t = -1.24 )</td>
<td>( t = 3.48 )</td>
<td></td>
</tr>
<tr>
<td>Mean absolute error (accuracy)</td>
<td>34.65%</td>
<td>28.80%</td>
<td>29.46%</td>
</tr>
<tr>
<td>Mean squared error</td>
<td>33.89%</td>
<td>15.94%</td>
<td>18.33%</td>
</tr>
<tr>
<td>Percentage within 15%</td>
<td>33.16%</td>
<td>34.26%</td>
<td>35.32%</td>
</tr>
<tr>
<td>( N )</td>
<td>1,897</td>
<td>1,897</td>
<td>1,897</td>
</tr>
<tr>
<td><strong>Constant Growth</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean signed error (bias)</td>
<td>-12.56%</td>
<td>-19.89%</td>
<td>-16.29%</td>
</tr>
<tr>
<td>( t = -7.37 )</td>
<td>( t = -14.88 )</td>
<td>( t = -11.17 )</td>
<td></td>
</tr>
<tr>
<td>Mean absolute error (accuracy)</td>
<td>50.50%</td>
<td>46.14%</td>
<td>46.74%</td>
</tr>
<tr>
<td>Mean squared error</td>
<td>52.82%</td>
<td>35.46%</td>
<td>40.22%</td>
</tr>
<tr>
<td>Percentage within 15%</td>
<td>15.81%</td>
<td>17.51%</td>
<td>17.85%</td>
</tr>
<tr>
<td>( N )</td>
<td>1,765</td>
<td>1,765</td>
<td>1,765</td>
</tr>
</tbody>
</table>

The table reports descriptive statistics for the prediction errors of two price estimates for actual share price for a sample of 357 S&P 500 industrial firms. The share prices are computed as follows:

\[
EPRC_t = \left[ V_t - (1 - \tau) \times ESO_t \right] e^{\delta h} / \text{Number of Common Shares}_t, \quad \text{and} \quad DPRC_t = VF_t / \text{Diluted Number of Shares}_t.
\]

\( V \) is firm equity value, which we compute using the residual income model and analysts’ earnings forecasts (see equation (5)). \( VF \) is the firm equity value before the after-tax present value of future employee stock option (ESO) grants (see equation (5)). \( FutESO \) is the present value of future grant expenses (see equation (9)). \( ESO \) is the value of existing ESOs, calculated using \( V \) and the modified warrant-pricing approach (see equation (3)). \( \tau \) is the marginal tax rate, calculated as the average effective tax rate in the past three years. In calculating \( V \) and \( VF \), we use two different terminal value computations. In panel A, we estimate the terminal value using the five-year-out value-to-book \( (VB5) \) technique given in equation (6). In panel B, we estimate the terminal value by assuming a constant 4% terminal growth rate \( (4\%g) \). In calculating \( FutESO \), we consider two assumptions on the growth of future ESO grant expenses. Under the decaying growth assumption, we assume future grant expenses grow at the I/B/E/S long-term growth rate forecast for five years and at 3% forever thereafter. Under the constant growth assumption, we assume future grant expenses grow at 3% forever.

We supplement the analysis in table 5 using a regression approach. Table 6 summarizes the results of regressing actual share price on the two price estimates. Following Kaplan and Ruback [1995], we use the logarithm transformation of the regression variables. The results are qualitatively similar without the transformation. We use the Fama-MacBeth regression method, which takes into account cross-correlations among firms. Specifically, we estimate the regression equation by year and compute the reported coefficients using the time-series averages of the annual coefficients and the reported \( t \)-statistics using the standard errors of the time series of the annual coefficients.

Both panels A and B in table 6 show that the estimated intercepts are positive and statistically different from zero. This result suggests that the
### TABLE 6
Fama-MacBeth Regressions of Actual Stock Price on Alternative Price Estimates

<table>
<thead>
<tr>
<th>Variable</th>
<th>Growth Assumption for Future ESO Grant Expenses</th>
<th>Decaying Growth</th>
<th>Constant Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td><strong>Panel A: V</strong>(VB5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>1.005</td>
<td>1.129</td>
<td>1.088</td>
</tr>
<tr>
<td></td>
<td>(9.73)***</td>
<td>(10.35)***</td>
<td>(14.06)***</td>
</tr>
<tr>
<td>DPRC</td>
<td>0.708</td>
<td>0.023</td>
<td>−0.102</td>
</tr>
<tr>
<td></td>
<td>(19.68)***</td>
<td>(0.21)</td>
<td>(−1.05)</td>
</tr>
<tr>
<td>EPRC</td>
<td>0.688</td>
<td>0.677</td>
<td>0.716</td>
</tr>
<tr>
<td></td>
<td>(20.77)***</td>
<td>(5.76)***</td>
<td>(24.63)***</td>
</tr>
<tr>
<td>Average R²</td>
<td>0.57</td>
<td>0.66</td>
<td>0.67</td>
</tr>
</tbody>
</table>

| **Panel B: V**(4%g) |                                              |                |                |                |                |
| Intercept | 2.214                                          | 2.185          | 2.252          | 2.144          | 2.206          |
|          | (8.08)***                                      | (8.60)***      | (8.30)***      | (8.23)***      | (8.08)***      |
| DPRC     | 0.404                                          | −0.178         | −0.287         |                |                |
|          | (4.58)***                                      | (−2.54)**      | (−4.14)***     |                |                |
| EPRC     | 0.421                                          | 0.582          | 0.429          | 0.698          |                |
|          | (5.15)***                                      | (8.94)***      | (5.14)***      | (13.34)***     |                |
| Average R² | 0.38                                          | 0.45           | 0.46           | 0.44           | 0.45           |

The table reports the Fama-MacBeth regression results of regressing the actual stock price on the price estimates for a sample of 357 S&P 500 industrial firms from 1996 to 2001. Specifically, we estimate the regression equation by year and compute the reported coefficients using the time-series averages of the annual coefficients and the reported t-statistics using the standard errors of the time series of the annual coefficients. The dependent variable is the stock price per share three months after the firms’ fiscal year-end, and the two share price estimates are calculated as follows:

\[
EPRC_t = \left[ V_t - (1 - \tau) \times ESO_t \right] e^{\delta h} \quad \text{and} \quad DPRC_t = \frac{VF_t}{\text{Diluted Number of Shares}_t}.
\]

\( V \) is firm equity value, which we compute using the residual income model and analysts’ earnings forecasts (see equation (5)). \( VF \) is the firm equity value before the after-tax present value of future employee stock option (ESO) grants (see equation (5)). \( FutESO \) is the present value of future grant expenses (see equation (9)). \( ESO \) is the value of existing ESOs, which we calculate using \( V \) and the modified warrant-pricing approach (see equation (3)). \( \tau \) is the marginal tax rate, calculated as the average effective tax rate in the past three years. In calculating \( V \) and \( VF \), we use two different terminal value computations. In panel A, we estimate the terminal value using the five-year-out value-to-book (VB5) technique given in equation (6). In panel B, we estimate the terminal value by assuming a constant 4% terminal growth rate (4%g). In calculating \( FutESO \), we consider two assumptions on the growth of future ESO grant expenses. Under the decaying growth assumption, we assume future grant expenses grow at the I/B/E/S long-term growth rate forecast for five years and at 3% forever thereafter. Under the constant growth assumption, we assume future grant expenses grow at 3% forever.

∗∗∗, ∗∗, and ∗ denote significance at the 1%, 5%, and 10% levels, respectively (two-tailed test).

Stock price estimates exhibit systematic biases across firms. The bigger intercepts reported in panel B (around 2, compared with around 1 in panel A) are consistent with the results in table 5 that the 4% terminal growth assumption systematically underestimates actual stock price more than does the VB5 terminal growth model. Because the regression intercept picks up any systematic bias in our \( V \) estimates, the regression approach allows us to compare the relative performance of the stock price estimates more precisely.
Regarding the stock price estimates, we find that both EPRC and DPRC exhibit significant power in explaining the cross-sectional variation in share prices. For instance, panel A shows that EPRC explains 66% of the cross-sectional variation in stock prices. Under the constant growth assumption for future grant expenses (column (4)), the estimated coefficient on EPRC is 0.716 (t-value = 24.63) in panel A and 0.429 (t-value = 5.14) in panel B. The results in column (1) indicate that DPRC also exhibits explanatory power for share price. However, all of the estimated coefficients on EPRC and DPRC are significantly different from one.

To compare the $R^2$s from the univariate DPRC and EPRC regressions, we perform Vuong’s [1989] tests for each of the six annual cross-sectional regressions 1996 to 2001. Results not tabulated show that across all four sets of valuation assumptions, EPRC has significantly higher explanatory power than does DPRC for actual share prices in all sample years except 2000 (in which the difference is not significant).

The results reported in columns (3) and (5) allow us to examine the incremental $R^2$s of the two share price estimates (the negative coefficients on DPRC in table 6, panel B are likely due to collinearity between the two price estimates). For example, under the constant growth assumption, EPRC has an incremental $R^2$ of 10% point (7% point in panel B), compared with the incremental $R^2$ of 1% point for DPRC (in both panels A and B). Thus, our test results suggest that EPRC has higher explanatory power than DPRC in explaining the cross-sectional variation in actual share price.

5.3 ROBUSTNESS CHECKS

Our sample period covers the late 1990s boom and the subsequent 2000s bust. To check the external validity of our results, we divide our sample into 1996–1999 and 2000–2001 subperiods. Consistent with the overall results reported in table 4, we find that the average DPRC is larger than the average EPRC in both subperiods. Moreover, the signed difference and the percentage with positive sign are larger in the 2000–2001 subperiod than in the 1996–1999 subperiod.

The qualitative findings for the prediction errors of the stock price estimates are similar to those reported in table 5. EPRC exhibits a lower prediction error than does DPRC in both subperiods. In addition, the prediction errors of both EPRC and DPRC are larger in the second subperiod than in the first subperiod.

We also conduct the cross-sectional regression analysis by subperiod. Because there are only four years in the first subperiod and two in the second, we estimate the regression using a year fixed-effects model. The subperiod results indicate that both stock price estimates have significant explanatory power for actual share price in univariate regressions, but EPRC has a larger incremental $R^2$ than does DPRC in both subperiods.

In this section we apply the warrant-pricing valuation approach to assess the valuation implications of dilution in estimating the fair value of ESO grants for financial reporting purposes. SFAS No. 123 (FASB [1995]) governs the current financial reporting requirements for ESOs. The requirements are that firms estimate the fair value of their ESO grants by using an option-pricing model and amortize the ESO grants over the vesting period of the options granted. The annual amortized cost is either reported in the income statement or disclosed in a footnote if the firm chooses not to expense.\(^{11}\)

In March 2003, the FASB put the option-expensing issue back on its agenda. The FASB did so in response to the Enron debacle and to the fact that the International Accounting Standards Board (IASB) issued a proposal (ED 2 Share-Based Payment) in November 2002 that would require option expensing. On March 31, 2004, the FASB released an exposure draft on share-based payment that would become effective for fiscal years beginning after December 15, 2004 (FASB [2004]). The proposed standard eliminates the intrinsic value method alternative allowed by SFAS No. 123. Instead, it requires the fair value of ESO grants be deducted as an expense in the computation of earnings (FASB [2004, ¶5]). Firms can choose the option-pricing model to estimate the fair value of the option grants. The exposure draft recommends a lattice (e.g., binomial) model over a closed-form (e.g., the BSM) model because the former is more flexible. Thus, it better captures changes in dividends and volatility, estimates of expected exercise and forfeiture patterns, and blackout and vesting periods. However, a closed-form model might be more practical if reasonable data and assumptions required by a lattice model are not readily available (FASB [2004, ¶B9–B12]). Predictably, there is strong opposition to the FASB’s current effort to recognize the cost of ESO grants as an expense.\(^{12}\)

One of the arguments against the expensing of ESO costs is based on the rationale that the traditional option-pricing model is not applicable in valuing ESOs. Partly in response to this, Huddart [1994], Hemmer, Matsunaga, and Shevlin [1994], Rubinstein [1995], Aboody [1996], and Carpenter [1998] develop ESO pricing models that take into account the special features of ESOs (e.g., nontransferability, nontradability, risk aversion, early

---

\(^{11}\) The deliberation that led to SFAS No. 123 was controversial. The exposure draft proposed the expensing of ESOs. However, pressure from major corporations, and eventually Congress, forced the FASB to back down on the proposal and allow firms to choose between expensing and disclosing (see Zeff and Dharan [1997, chap. 10] and Dechow, Hutton, and Sloan [1996] for details).

exercise, vesting requirement, long maturity). However, with the exception of Rubinstein [1995], no researcher considers the dilutive effect of ESOs on the valuation of option grants.\textsuperscript{13}

The current and proposed standards for ESOs do not address the dilutive features of ESOs in estimating the fair value of ESO grants for financial reporting purposes. Thus, the valuation implications of the dilutive feature could be of interest to the reporting companies, financial statement users, and regulators. The warrant-pricing model explicitly takes into account the dilution due to ESOs; therefore, it can be used, along with the option-pricing model, to compare the fair values of ESO grants estimated with and without the dilution adjustment.

To make a proper comparison between the fair-value estimates from the option- and warrant-pricing models, we must take into account the fact that the assets underlying options and warrants are different. The option-pricing formula derives the value of an option as a function of the price of the underlying stock, $s$. However, the value of a warrant is derived from 

$$v = se^{-bh} + (m/n)w,$$

which is the firm equity value attributed to both stocks and ESOs. Thus, to make a fair comparison of the values estimated from the two models, we must determine $s$ and $v$ within a consistent framework. The valuation approach discussed in section 2.1 provides just such a consistent framework because we estimate both $v$ and $s$ from the same underlying firm equity value; therefore, both are based on the same set of fundamental assumptions and forecasts (e.g., analysts’ forecasts, discount rate, terminal growth rate, and growth in future option grants).

We assume that security price is set according to equation (10). We use $EPRC$ and the option-pricing formula to compute the fair value of ESO grants and label this estimate $GOPT$. This estimate gives the non-dilution-adjusted value of the ESO grants. It is also the fair value that a hypothetical company would use to compute ESO-based compensation expenses under the current and proposed accounting standards. We compare this non-dilution-adjusted fair value estimate with the estimate we compute using our warrant-based valuation method. We call the warrant-based estimate $GESO$. Given that $EPRC$ is derived from $V$, both $GOPT$ and $GESO$ are derived from the values of their underlying assets estimated using the same set of fundamental assumptions and forecasts. We attribute the difference between the option- and warrant-based fair-value estimates to the dilutive feature of ESOs.

Table 7 presents statistics for the estimated values of ESO grants. In panel A, we find that under the decaying and constant grant expense growth

\textsuperscript{13} Rubinstein [1995] uses a hypothetical firm to illustrate the use of a binomial model that takes into account all the special characteristics of ESOs. He finds that the value estimate is very sensitive to 10 model parameters used to incorporate the specific characteristics of ESOs. However, he does not separately examine or report the valuation implications of dilution while holding other features constant. Our analysis focuses exclusively on the valuation difference due to the dilutive feature of ESOs.
assumptions, the mean (median) values of ESO grants estimated by the option-pricing model, $G_{OPT}$, are $148$ million ($38$ million) and $173$ million ($41$ million), respectively. The corresponding warrant-based estimates, $G_{ESO}$, are $125$ million ($36$ million) and $145$ million ($39$ million), respectively. The median percentage difference between $G_{ESO}$ and $G_{OPT}$ is 6% of $G_{ESO}$ for all four sets of valuation assumptions. However, the percentage difference varies widely across firms, as shown by the relatively large interquartile ranges and standard deviations. Thus, if the median sample firm estimated the fair value of ESO grants without accounting for the dilutive

<table>
<thead>
<tr>
<th>Variable</th>
<th>Panel A: $V(VB5)$</th>
<th>Panel B: $V(4%g)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$G_{OPT}$ ($\text{SMM}$)</td>
<td>1,875</td>
<td>1,746</td>
</tr>
<tr>
<td>$G_{ESO}$ ($\text{SMM}$)</td>
<td>1,875</td>
<td>1,746</td>
</tr>
<tr>
<td>$(G_{OPT} - G_{ESO})/G_{ESO}$</td>
<td>1,875</td>
<td>1,746</td>
</tr>
<tr>
<td>Basic dilution factor (%)</td>
<td>1,875</td>
<td>1,746</td>
</tr>
<tr>
<td>Log(market value of equity)</td>
<td>1,875</td>
<td>1,746</td>
</tr>
<tr>
<td>R&amp;D/sales</td>
<td>1,740</td>
<td>1,740</td>
</tr>
<tr>
<td>Executive options (%)</td>
<td>1,740</td>
<td>1,740</td>
</tr>
</tbody>
</table>

The table reports descriptive statistics for the estimated value of employee stock option (ESO) grants, using the option-pricing and warrant-pricing models, for a panel of 357 S&P 500 industrial firms from 1996 to 2001. $G_{OPT}$ is the value of options granted, calculated using the option-pricing model and the stock price estimated per equation (10). $G_{ESO}$ is the value of ESOs granted, calculated using the warrant-pricing model. The basic dilution factor is the number of ESOs outstanding divided by the sum of the numbers of ESOs and shares outstanding. We compute the market value of equity by using the closing stock price three months after the fiscal year-end times the number of shares outstanding. R&D/sales is the R&D expenses for the year, scaled by net sales for the year. We set R&D/sales to zero if the R&D expense is missing. The executive options are the percentage of all outstanding ESOs that are held by the top five executives. In calculating $V$ and $W$, we use two different terminal value computations. In panel A, we estimate the terminal value using the five-year-out value-to-book ($VB5$) technique given in equation (6). In panel B, we estimate the terminal value by assuming a constant 4% terminal growth rate ($4\%g$). In calculating FutESO, we consider two assumptions on the growth of future ESO grant expenses. Under the decaying growth assumption, we assume future grant expenses grow at the I/B/E/S long-term growth rate forecast for five years and at 3% forever thereafter. Under the constant growth assumption, we assume future grant expenses grow at 5% forever.

### Table 7

**Descriptive Statistics on ESO Grant Values Estimated Using the Option- and Warrant-Pricing Models**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Growth Assumption for Future ESO Grant Expenses</th>
<th>Std. Dev. Q3–Q1</th>
<th>Std. Dev. Q3–Q1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Decaying Growth</td>
<td>Constant Growth</td>
<td></td>
</tr>
<tr>
<td>$N$</td>
<td>Mean, Median, Dev. Q1</td>
<td>Mean, Median, Dev. Q1</td>
<td></td>
</tr>
<tr>
<td>$G_{OPT}$ ($\text{SMM}$)</td>
<td>1,875</td>
<td>147.73</td>
<td>37.80</td>
</tr>
<tr>
<td>$G_{ESO}$ ($\text{SMM}$)</td>
<td>1,875</td>
<td>124.80</td>
<td>35.87</td>
</tr>
<tr>
<td>$(G_{OPT} - G_{ESO})/G_{ESO}$</td>
<td>1,875</td>
<td>0.14</td>
<td>0.06</td>
</tr>
<tr>
<td>Basic dilution</td>
<td>1,875</td>
<td>0.07</td>
<td>0.07</td>
</tr>
<tr>
<td>Log(market value of equity)</td>
<td>1,875</td>
<td>8.97</td>
<td>8.82</td>
</tr>
<tr>
<td>R&amp;D/sales</td>
<td>1,740</td>
<td>0.04</td>
<td>0.01</td>
</tr>
<tr>
<td>Executive options (%)</td>
<td>1,740</td>
<td>17.34</td>
<td>14.06</td>
</tr>
</tbody>
</table>
feature of ESOs, it would overstate its ESO-related compensation by about 6%.

We note that the estimated fair values from the two models give the costs of the ESO granted in a particular year. The current and proposed accounting standards for stock-based compensation require the estimated fair value of ESO grants to be amortized over the vesting period. Therefore, unless we make additional assumptions about ESOs granted in the past and about their vesting periods, we cannot speak to the effect of dilution on actual ESO expenses. However, if we assume that a firm grants the same value of ESOs each year with the same vesting period (as in a steady-state situation), our estimates of the ESO grant cost for a particular year will equal that of the actual ESO expense reported by the firm under the current and proposed standards.

Next, we investigate whether there are systematic factors that can explain the difference between the grant value estimates from the option- and warrant-pricing models. In general, the opponents of ESO expensing are firms that rely on ESOs for compensation. Therefore, we test whether these firms are likely to be affected the most if they ignore the dilutive feature of ESOs in the fair value computation.

First, we examine whether the percentage difference between $G_{OPT}$ and $G_{ESO}$ is related to the intensity of ESO usage by the sample firms. We capture ESO usage by using the basic dilution factor measure, which we compute as the number of ESOs outstanding scaled by the number of shares and ESOs outstanding. We note that ESO intensity does not have a mechanical relation with the dependent variable. The dependent variable measures the difference between the option- and warrant-based estimates of the current year’s ESO grant value. On the other hand, ESO intensity measures the extent of ESO usage and is calculated using all ESOs outstanding (not just the current year’s grants). We use ESO intensity as a catch-all variable to capture the characteristics of firms that are heavy users of ESOs. The second specification uses the fundamental variables (size, R&D intensity, and broad-based ESO plan) to directly measure these firm characteristics.

Second, we directly link the difference in grant value estimates to the firm characteristics that are associated with ESO-intensive firms: the natural logarithm of the market value of equity, the ratio of R&D to sales, and the ratio of executive options to all ESOs outstanding. The ratio of R&D to sales captures a firm’s high-technology and growth features. We use the ratio of executive options to all ESOs outstanding to capture broad-based ESO usage within a company. Table 7 reports the descriptive statistics for these explanatory variables. On average, the dilution factor of the sample firms is 7% and the top five executives hold about 17% of all ESOs outstanding. The average and median ratios of R&D to sales are 0.04 and 0.01, respectively.

Table 8 reports the Fama-MacBeth regression results for all four combinations of valuation assumptions. The results in columns (1) and (3) show that the basic dilution factor is positively related to the percentage difference
The table reports the results of Fama-MacBeth regressions for a panel of 357 S&P 500 industrial firms from 1996 to 2001. Specifically, we estimate the regression equation by year and compute the reported coefficients using the time-series averages of the annual coefficients and the reported t-statistics using the standard errors of the time series of the annual coefficients. The dependent variable is \((GOPT - GESO) / GESO\), the percentage differences in employee stock option (ESO) grant values that we estimate using the option- and warrant-pricing models. \(GOPT\) is the value of options granted, calculated using the option-pricing model and stock price calculated per equation (10). \(GESO\) is the value of ESOs granted, calculated using the warrant-pricing model. The basic dilution factor is the number of ESOs outstanding divided by the sum of the number of ESOs and shares outstanding. We compute the market value of equity by using the closing stock price three months after the fiscal year-end times the number of shares outstanding. R&D/sales is the R&D expenses for the year, scaled by net sales for the year. We set R&D/sales to zero if the R&D expense is missing. In calculating \(V\) and \(VF\), we use two different terminal value computations. In panel A, we estimate the terminal value using the five-year-out value-to-book (\(VB5\)) technique given in equation (6). In panel B, we estimate the terminal value by assuming a constant 4% terminal growth rate (\(4\%g\)). In calculating \(FutESO\), we consider two assumptions on the growth of future ESO grant expenses. Under the decaying growth assumption, we assume future grant expenses grow at the I/B/E/S long-term growth rate forecast for five years and at 3% forever thereafter. Under the constant growth assumption, we assume future grant expenses grow at 3% forever. **, *, and * denote significance at the 1%, 5%, and 10% levels, respectively (two-tailed test).
between the two fair-value estimates. Furthermore, its estimated coefficients are highly significant, except in panel B, when we choose the constant grant expense growth assumption. For instance, in column (3) of panel A, the coefficient on the dilution factor is 2.272 with a t-value of 7.77. Hence, a 1 standard deviation increase in the dilution factor will increase the percentage difference between \( G_{OPT} \) and \( G_{ESO} \) by 9.1% points.

In the multiple regressions reported in columns (2) and (4), we find that the market value of equity is negatively correlated with the percentage difference between \( G_{OPT} \) and \( G_{ESO} \) in all regressions. In addition, R&D intensity is positively associated with the percentage difference in panel A (e.g., the estimated coefficient on the ratio of R&D to sales is 0.798 with a t-value of 3.36 under the constant grant growth assumption). Furthermore, the results in table 8, panel B indicate that firms without a broad-based ESO plan (i.e., top executives hold most of the outstanding ESOs) exhibit a lower difference between the two fair value estimates.

6.1 ROBUSTNESS CHECKS

We also perform another subperiod analysis on the key results reported in tables 7 and 8. Findings not tabulated indicate that if we compute the terminal value using the \( VB5 \) assumption (panel A), the median differences between the option- and warrant-based grant value estimates are 5% and 7% in the 1996–1999 and 2000–2001 subperiods, respectively. When we calculate the terminal value using the 4% growth assumption (panel B), the corresponding figures are 4% and 8% for the two subperiods, respectively. Furthermore, the median basic dilution factor is 6% and 8% for the two subperiods, respectively. This finding suggests that the number of ESOs outstanding increases in the 2000–2001 subperiod relative to the 1996–1999 subperiod.

We conduct the regression analysis reported in table 8 by subperiod, using a year fixed-effects model. We find that the subperiod results are qualitatively similar to those reported in table 8. However, the subperiod results are less significant statistically than the reported findings when we compute the terminal value using the 4% growth assumption (panel B).

7. Conclusions

We examine the use of a warrant-pricing approach to incorporate ESOs into equity valuation. We also use this approach to assess the valuation implications of dilution on the fair-value estimate of option grants for financial reporting purposes.

We use the RI formulation of the DCF model and security analyst consensus forecasts to estimate firm equity value that is attributed to both current shareholders and ESO holders. Based on a panel of 357 industrial firms in the S&P 500 index from 1996 to 2001, we find that our stock price estimate is, on average, lower than that generated from the traditional valuation method. Our price estimate is also closer to the actual stock price than its
traditional counterpart. In cross-sectional regressions of contemporaneous share price on the two stock price estimates, our price estimate exhibits higher explanatory power than does the traditional pricing method.

We apply our valuation framework to assess the valuation implications of dilution in estimating the fair value of ESO grants. We examine the fair-value estimates of ESO grants calculated using the option- and warrant-pricing formulas. Our findings suggest that if firms were required to expense ESO costs, as proposed by the exposure draft (FASB [2004]), the use of an option-pricing model without adjusting for dilution would overstate the fair value of ESO grants and, thus, the ESO-related compensation expenses. This is the case especially for heavy ESO users, for small firms, and, to certain extent, for R&D-intensive firms and firms with broad-based ESO plans. These empirical findings might provide the FASB and reporting companies with evidence regarding the use of a warrant-pricing approach to account for the dilutive feature of ESOs in the computation of ESO-based compensation costs.

APPENDIX

Excerpt from Note G to the 1996 Financial Statements of The GAP Inc.

NOTE G: STOCKHOLDERS’ EQUITY AND STOCK OPTIONS

Under the Company’s Stock Option Plans, nonqualified options to purchase common stock are granted to officers and key employees at exercise prices equal to the fair market value of the stock at the date of grant or at other prices as determined by the Board of Directors.

Stock option activity for all employee benefit plans was as follows:

<table>
<thead>
<tr>
<th></th>
<th>Shares</th>
<th>Weighted-Average Exercise Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balance at January 29, 1994</td>
<td>7,151,086</td>
<td>$12.12</td>
</tr>
<tr>
<td>Granted</td>
<td>2,310,800</td>
<td>22.45</td>
</tr>
<tr>
<td>Exercised</td>
<td>(1,249,612)</td>
<td>8.73</td>
</tr>
<tr>
<td>Cancelled</td>
<td>(465,730)</td>
<td>19.97</td>
</tr>
<tr>
<td>Balance at January 28, 1995</td>
<td>7,746,544</td>
<td>$15.27</td>
</tr>
<tr>
<td>Granted</td>
<td>9,484,400</td>
<td>17.91</td>
</tr>
<tr>
<td>Exercised</td>
<td>(994,372)</td>
<td>9.72</td>
</tr>
<tr>
<td>Cancelled</td>
<td>(596,148)</td>
<td>18.41</td>
</tr>
<tr>
<td>Balance at February 3, 1996</td>
<td>15,640,424</td>
<td>$17.11</td>
</tr>
<tr>
<td>Granted</td>
<td>6,242,740</td>
<td>30.90</td>
</tr>
<tr>
<td>Exercised</td>
<td>(1,591,174)</td>
<td>12.45</td>
</tr>
<tr>
<td>Cancelled</td>
<td>(799,072)</td>
<td>22.28</td>
</tr>
<tr>
<td>Balance at February 1, 1997</td>
<td>(19,492,918)</td>
<td>$21.69</td>
</tr>
</tbody>
</table>

Outstanding options at February 1, 1997 have expiration dates ranging from March 20, 1997, to January 29, 2007, and represent grants to 1,793 key employees.
At February 1, 1997, the Company reserved 34,239,852 shares of its common stock for the exercise of stock options. There were 14,749,234 and 190,602 shares available for granting of options at February 1, 1997, and February 3, 1996, respectively. Options for 2,915,481 and 2,946,164 shares were exercisable as of February 1, 1997, and February 3, 1996, respectively, and had a weighted-average exercise price of $13.52 and $12.38 for those respective periods.

The Company accounts for its Stock Option and Award Plans in accordance with APB Opinion No. 25, under which no compensation cost has been recognized for stock option awards granted at fair market value. Had compensation cost for the Company’s three stock-based compensation plans been determined based on the fair value at the grant dates for awards under those plans in accordance with the provisions of SFAS No. 123, Accounting for Stock-Based Compensation, the Company’s net earnings and earnings per share would have been reduced to the pro forma amounts indicated below. The effects of applying SFAS No. 123 in this pro forma disclosure are not indicative of future amounts. SFAS No. 123 does not apply to awards prior to fiscal year 1995. Additional awards in future years are anticipated.

<table>
<thead>
<tr>
<th></th>
<th>1996</th>
<th>1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Earnings ($000)</td>
<td>As reported $452,859</td>
<td>$354,039</td>
</tr>
<tr>
<td></td>
<td>Pro forma $437,232</td>
<td>$348,977</td>
</tr>
<tr>
<td>Earnings per share</td>
<td>As reported $1.60</td>
<td>$1.23</td>
</tr>
<tr>
<td></td>
<td>Pro forma $1.54</td>
<td>$1.21</td>
</tr>
</tbody>
</table>

The weighted-average fair value of the stock options granted during fiscal 1996 and 1995 was $11.21 and $6.27, respectively. The fair value of each option granted is estimated on the date of the grant using the Black-Scholes option-pricing model with the following weighted-average assumptions for grants in 1996 and 1995: dividend yield of 1.0 percent for all years; expected price volatility of 30 percent; risk-free interest rates ranging from 5.5 percent to 6.5 percent; and expected lives between 3.5 and 6 years.

The following table summarizes information about stock options outstanding at February 1, 1997:

<table>
<thead>
<tr>
<th>Range of Exercise Prices</th>
<th>Number Outstanding at 2/1/97</th>
<th>Weighted-Average Remaining Contractual Life (in years)</th>
<th>Weighted-Average Exercise Price</th>
<th>Number Exercisable at 2/1/97</th>
<th>Weighted-Average Exercise Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>$4.76–$15.69</td>
<td>2,825,688</td>
<td>4.31</td>
<td>$12.38</td>
<td>2,173,888</td>
<td>$11.42</td>
</tr>
<tr>
<td>15.72–16.94</td>
<td>4,001,690</td>
<td>6.09</td>
<td>16.10</td>
<td>970,023</td>
<td>16.29</td>
</tr>
<tr>
<td>17.09–22.59</td>
<td>7,186,470</td>
<td>6.10</td>
<td>20.23</td>
<td>593,970</td>
<td>19.81</td>
</tr>
<tr>
<td>22.69–35.44</td>
<td>5,479,070</td>
<td>9.25</td>
<td>32.51</td>
<td>50,600</td>
<td>24.36</td>
</tr>
<tr>
<td>$4.76–$35.44</td>
<td>19,492,918</td>
<td>6.72</td>
<td>$21.69</td>
<td>2,915,481</td>
<td>$13.52</td>
</tr>
</tbody>
</table>
REFERENCES


