A Numerical Model of ESO Grants Under Different Regulatory Regimes and Share Repurchase Strategies

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1. Introduction

In recent years employee stock options (ESO) became both a widely adopted compensation instrument and a subject of controversy related to the methods of their valuation, their accounting treatment and their effect on other key elements of the corporate financial policy. The results of several empirical studies documented a close link between share repurchases and ESO grants [see e.g. Fenn and Liang (2001), Kahle (2002), Bens et al. (2003) and Larcker (2003)]. This paper contributes to the existing literature by examining this link in a quantitative model which takes into account the regulatory differences in the ESO treatment in various jurisdictions. In such a framework both the regulatory and financial management determinants influencing corporate ESO grants may be analyzed at the same time. The ability to perform such analysis is particularly relevant in view of the recent introduction of the new accounting standards for share-based compensation in the European Union and in the United States. The next section develops a stochastic model to study the influence of regulatory environment and repurchase strategy on ESO grant decisions. Section 3 presents and discusses the results of two numerical experiments obtained with the model. Section 4 concludes.

2. A model of the corporate decision to grant ESO

A numerical model is constructed below to study the impact of corporate tax benefits, option expensing regime, stock market price level and repurchase strategy, as well as some other parameters on the ESO grant decision (for more background see Grabowski, 2005). More specifically, the objective is to compare, first, the decision to offer cash compensation vs. options in the ESO expensing regime, second, the decision to issue ESO in the tax benefit vs. no tax benefit regime and third, the impact of the different market share price levels on the ESO issue decision.

While previous studies emphasized employee ESO valuation problems (see Grabowski (2006) for a review), we focus here on a firm concentrating on a financial management policy to maximize its earnings per share within the existing accounting and tax regime. The objective of a firm in the model is therefore to choose a compensation-repurchase strategy with higher expected earnings per share (EPS) at ESO exercise date, i.e. after the closing of its short option position resulting from its ESO strategy, under different expensing and tax regimes. We formulate the expected EPS functions for the cash-only compensation case as well as for the ESO grants under different regulatory and repurchase scenarios. In addition to the cash-compensation case, there are nine cases of ESO grants, since within each of the three selected regulatory regimes three specific repurchase strategies described below may be adopted. The expected EPS for each of these ten cases is then computed using Monte Carlo simulation.

To include in the model the employee decision to accept ESO compensation the amount of cash compensation and the number of options granted is calculated starting from a fixed cash compensation level net of personal tax which is the same for all scenarios. The firm is thus faced with the problem of choosing the optimal form of payment for a fixed level of compensation demanded by the employees. In other research much space was devoted to the investigation of the impact of employee valuation of ESO on the option issuing activity [see e.g. Hall and Murphy (2002), Oyer and Schaefer (2006)]. That research was usually utility-based and emphasized risk and portfolio characteristics of the employee. In contrast, we assume here that employees are risk-neutral, and that they are interested alone in the expected present value of the after-tax cash compensation they receive. This required after-(personal) tax compensation level forms the basis of the pre-tax cash salary and the number of options granted. The employees value options with the standard BS model. It is assumed that the shares received in option exercise are sold immediately and taxed only on exercise with a personal tax rate pt and that no further tax obligation is incurred later. The vesting, expiry, exercise and taxation time thus coincide in a single date T.

Three regulatory regimes E1–3 are studied:

— E1. No expensing/no tax benefit.

— E2. No expensing/tax-benefit on exercise.

— E3. Expensing at a φ_1 fraction of the BS option value.

The initial data for the model firm are the following: the number of its shares outstanding n and its pre-compensation decision net profit p_c. The cash compensation level sl_1, in the cash-only scenario CS, included in the profit statement of the firm for a fixed after-tax level of employee compensation sl is

$$sl_1 = \frac{sl}{1-pt}$$

and the number of options k granted at time t_0 for the same level of sl is computed as

$$k = \frac{sl}{\varphi_1 \cdot bsc_0 \cdot (1-pt)}$$

where bsc_0 is the Black-Scholes t_0 (grant/issue time) value of the European option with the time to expiry T and the exercise price K equal to the current share price S_0 of the ESO granting firm (it is assumed that the options are granted at-the-money). The parameter φ_1 is a valuation adjustment parameter, reflecting firm's valuation discretion under SFAS 123R. It is less or equal to one in the option-expensing case E3 and equal to one in the E1 and E2 cases.

For each of the expensing regimes E_i we study three examples of share repurchase strategies, reflecting a management decision to reduce or eliminate the EPS dilution brought about by ESO exercise.

In the first strategy, R1, the firm waits until the actual option exercises are executed and then repurchases shares at the exercise-time T share price S_T for the sum of cash received by issuing shares in exercises i.e. $k : S_0$ kin the no tax-benefit cases E1 and E3, and for the share issue price plus tax benefit based on the corporate tax rate ct in the case E2: $k \cdot \left[S_0 + ct \cdot (S_T - S_0)\right]$. There is no repurchase if no options are exercised.

In the second strategy, R2, which is a reduced-form delta-hedging strategy, the firm repurchases $\varphi_1 \cdot \Delta \cdot k$ shares upon issuing the ESO, and then repurchases further $(1 - \varphi_1 \cdot \Delta \cdot k)$ shares, but only if ESO are exercised. In tax benefit case E2, there is also additional repurchase in case of exercise for the amount of received tax benefit.

In the case R3, an example of a possibly more realistic corporate strategy, the firm waits until time t_1 to repurchase its k shares but then executes the repurchase only if the share price at that time is at or below a fraction φ_2 of the initial share price S_0. Again, shares are also repurchased in case of ESO exercise for the amount of the tax benefit.

While in the case R1 the buyback is carried out with the cash flow induced by ESO exercise alone, it is assumed in the cases R2 and R3, that the t_0 and t_1 repurchases are costly and reduce the terminal net profit by the risk-free interest on the t_0 or t_1 repurchase amount. In addition, the strategies R2 and R3 may not be leverage-neutral, in contrast to the strategy R1. There will be an increase in leverage if there is no ESO exercise in the R2 and R3 cases and if the repurchases were not financed from the free cash balances.

So, in total, there are ten compensation-repurchase cases: the cash-compensation scenario CS and nine regulatory-repurchase scenarios $E_i - R_j$.

The time T EPS is driven by the stochastic processes for the net profit of the firm p, and for its market share price S, modeled as two standard GBM processes with the correlation coefficient ρ:

$$\frac{dp}{p} = \mu_p dt + \sigma_p dW_p$$

$$\frac{dS}{S} = \mu_S dt + \sigma_S dW_S$$

The t_0 initial net profit value p_0 will vary for different strategies. In the CS strategy its value will be equal to p_c minus after-corporate tax cash compensation:

$$p_{0,\,CS} = p_c - sl_1 \cdot (1 - ct)$$

In the option-expensing strategies E3, the p_0 will be equal to p_c minus the option expensing charge net of tax:

$$p_{o,\,E3} = p_c - k \cdot \varphi_1 \cdot bsc_0 \cdot (1 - ct)$$

The EPS in the cash-compensation scenario eps_{CS} is computed as $eps_{cs} = \frac{p_T}{n}$. The EPS in the $E_i - R_j$ scenarios, given the initial net profit p_0 and share price S_0, is:

$$eps_{E_i - R_J} = \frac{p_T - c_{ij}}{n + k - x_{ij} - y_{ij}} \cdot I_{\{S_T > S_0\}} + \frac{p_T - c_{ij}}{n - z_{ij}} \cdot I_{\{S_T \leq S_0\}}$$

where $I_{\{a\}}$ is an indicator function equal to one if the condition {a} holds and to zero otherwise. The c, x, y and z terms change for a particular strategy $E_i - R_j$ ($\varphi_1 = 1$ for $i = 1, 2$):

$$x_{i1} = \frac{k \cdot S_0}{S_T},\ x_{i2} = \varphi_1 \cdot \Delta \cdot k + \frac{(1 - \varphi_1 \cdot \Delta) \cdot k \cdot S_o}{S_T} \text{ and } x_{i3} = k \cdot I_{(S_{t1} < \varphi_2 \cdot S_0)},\ \text{for all } i$$

$$y_{2j} = \frac{k \cdot ct \cdot (S_T - S_0)}{S_T},\ \text{for all } j, \text{ and zero otherwise}$$

$$z_{i1} = 0,\ z_{i2} = \varphi_1 \cdot \Delta \cdot k \text{ and } z_{i3} = k \cdot I_{(S_{t1} < \varphi_2 \cdot S_0)},\ \text{all } i$$

$$c_{i1} = 0,\ c_{i2} = \varphi_1 \cdot \Delta \cdot k \cdot S_0 \cdot r \cdot T \cdot (1 - ct)$$

$$\text{and } c_{i3} = k \cdot S_{t1} \cdot I_{(S_{t1} < \varphi_2 \cdot S_0)} \cdot r \cdot (T - t_1) \cdot (1 - ct),\ \text{all } i$$

The expected EPS values at T for all scenarios are computed numerically using Monte Carlo simulation with the initial values of $p_0 = p_{o,\,CS}$ for eps_{CS}, $p_0 = p_{0,\,E3}$ for $E_3 - R_j$, all j, cases, and $p_0 = p_c$ in all other cases.

3. The results of the numerical experiments

To investigate the research questions formulated earlier we perform the Monte Carlo simulations for all ten scenarios for a set of corporate data and selected parameter values using the model developed in the previous section.

The set of corporate data used in the numerical experiments is based on the financial data of Nokia reported in 2002 with some modifications. In 2002 Nokia had net profit of €3.38bn (p_c) and had 4.75bn (n) shares outstanding, resulting in the EPS of €0.71. Nokia was subject to the corporate tax rate of 29%. It had compensation costs (wages and salaries) of €2.53bn and issued 51m options (ca. 1% of shares outstanding) that year. The average exercise price was €17.96 and the market price range for Nokia shares in 2002 was €11.10–29.45.

In the numerical experiments we test the case of S_0 equal to €18, and for the case of S_0 of €11, to investigate the effect of grants at low share price. The size of the salary to be paid out in ESO form is fixed at €750m (sl), roughly three times the BS value of the Nokia grant, corresponding to the level of 3% of shares outstanding and 30% of total compensation costs. The exercise price K of options is equal to S_0.

We perform two experiments. In the first experiment we simulate the case of the fixed option maturity T, equal to three years. In the second experiment we investigate the influence of the changes in the expiry/vesting time T adopted in the grant on the option compensation decision.

In the first experiment some parameters are changed in each simulation to study the impact of different personal and corporate tax levels, profit and share price process characteristics, as well as the effect of reduced BS option valuation.

The results of the first experiment and parameter sets for each case are presented in the Tables 1A and 1B.

The following observations can be made:

— in the no expensing regimes (E1, E2) the tax benefit seems to have a minimal impact on the EPS figure for all repurchase scenarios at the selected expiry T.

— the R3 repurchase strategy clearly dominates other strategies, with R2 strategy producing the worst results.

— the difference between the CS strategy and the E3-R3 strategy is minimal indicating the important role played by the repurchase strategy choice in the ESO policy.

— the value of the parameters of the share price process (μ_s, σ_s) also has virtually no impact on the EPS and in consequence on the ESO issue decision.

— there is high sensitivity to the parameters of the profit process, in particular to μ_p.

— there seems to be little change in the results in the case when both employees and the firm value ESO at less than its BS value.

— higher correlation between profit and share price processes affects expected EPS negatively.
— lower taxes, both corporate and personal, do not seem to have a large impact on the ESO adoption.

In the second experiment the parameter set is fixed, except the time to expiry T. It is assumed in the R3 strategy, that the repurchases are made always after two years from the option issue, if the share price is equal to or less than 80% of the exercise price. The experiment is performed again for S_0 equal to 18 and to 11. Further, the risk-free interest rate is lowered to 3% from the first experiment to check the effect of lower financing costs of the repurchases.

The results of the second experiment are presented in the Tables 2A and 2B. Again, the repurchase strategy R3 dominates other repurchase strategies, while the strategy R2 fares worst. However, the R2 results are better reflecting lower repurchase financing costs due to the lower interest rate. There seems to be a positive value to waiting to repurchase at lower prices. The difference between the expected EPS for the cash and the ESO expensing case is larger for longer maturities, which might indicate a shift to shorter ESO maturities in the expensing regime is optimal. The expected EPS values for the R1 strategy are closer to R3 strategy in the case of $S_0 = 18$, indicating that the share price level at ESO issue may influence optimal repurchase strategy.

The simulations carried out with the model indicate that the ESO tax benefits do not seem to influence significantly the ESO grant decision. They show further that the introduction of option expensing does not necessarily eliminate the attraction of ESO compensation, a fact supported by the actual corporate practice. An important role is played by the ESO plan management including the choice of share repurchase strategy. The share price level and the interest rate seem to impact the ESO grant policy through their effect on repurchase strategy.

4. Conclusion and further research

The model developed in this paper allows studying quantitatively the determinants of the ESO grant decision for a firm aiming to maximize its EPS, under various regulatory regimes characterized by the accounting and taxation rules that govern share-based compensation, and under different share repurchase strategies. In particular, the model is used to investigate possible effects of the recent introduction of the new accounting standards for ESO on the corporate option grant policy. The main results obtained using Monte Carlo simulations show that a shift to shorter ESO maturities could be desirable in the option expensing regime, and that the share repurchase strategy selected by the firm to manage its option plan could play a decisive role in determining its scale of the ESO adoption. Even with option expensing ESO grants may be still preferred to cash compensation by companies with an adequate repurchase strategy.

Further research could extend these findings by overcoming many important limitations of the model. The choice of the stochastic processes for the share price and the net profit could have influenced the results. The number of options issued adopted in simulations was not a large percentage of the outstanding shares, as only a decision to issue options in a single year was investigated. In practice, annual grants accumulate and may impact both the grant and the repurchase decisions. No explicit link between the grant and the employee work effort was included. Since only a few repurchase strategies were studied in this paper, a more comprehensive examination of such strategies and their influence on compensation policy under different accounting and tax regimes seems particularly desirable.

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Table 1A

Case	$\varphi_1 = 0.8$ $\sigma_p = 0.3$	$\sigma_p = 0.3$		$\mu_p = 0.3$, $\sigma_p = 0.7$	$\varphi_1 = 0.8$, $\mu_p = 0.3$, $\sigma_p = 0.7$	$\mu_s = 0.3$, $\sigma_s = 0.7$	$\rho = 0.8$	$pt = 0.2$	$ct = 0.2$	$ct = 0.2$, $pt = 0.2$
CS	1,016	1,017	1,017	1,371	1,373	1,016	1,016	1,053	0,976	1,018
E1-R1	1,294	1,295	1,293	1,743	1,744	1,289	1,289	1,294	1,292	1,294
E1-R2	1,272	1,272	1,269	1,723	1,726	1,269	1,264	1,273	1,263	1,269
E1-R3	1,304	1,305	1,301	1,751	1,750	1,296	1,296	1,300	1,299	1,299
E2-R1	1,297	1,297	1,296	1,747	1,748	1,293	1,294	1,297	1,295	1,295
E2-R2	1,275	1,275	1,272	1,730	1,731	1,276	1,269	1,276	1,265	1,270
E2-R3	1,307	1,308	1,304	1,756	1,751	1,298	1,298	1,304	1,301	1,302
E3-R1	1,007	1,010	1,008	1,357	1,354	1,004	1,007	1,045	0,968	1,009
E3-R2	0,980	0,982	0,979	1,335	1,332	0,983	0,977	1,020	0,931	0,978
E3-R3	1,016	1,015	1,012	1,364	1,363	1,007	1,008	1,048	0,971	1,013

Table 1B

Case	$\varphi_1 = 0.8$ $\sigma_p = 0.3$	$\sigma_p = 0.3$		$\mu_p = 0.3$, $\sigma_p = 0.7$	$\varphi_1 = 0.8$, $\mu_p = 0.3$, $\sigma_p = 0.7$	$\mu_s = 0.3$, $\sigma_s = 0.7$	$\rho = 0.8$	$pt = 0.2$	$ct = 0.2$	$ct = 0.2$, $pt = 0.2$
CS	1,016	1,016	1,017	1,375	1,374	1,017	1,017	1,053	0,976	1,016
E1-R1	1,289	1,289	1,285	1,731	1,731	1,281	1,281	1,287	1,286	1,288
E1-R2	1,280	1,280	1,276	1,734	1,735	1,275	1,270	1,279	1,271	1,274
E1-R3	1,309	1,309	1,302	1,752	1,750	1,289	1,291	1,301	1,300	1,300
E2-R1	1,294	1,294	1,291	1,737	1,739	1,286	1,289	1,293	1,290	1,292
E2-R2	1,285	1,285	1,282	1,740	1,739	1,281	1,276	1,284	1,271	1,277
E2-R3	1,314	1,313	1,308	1,760	1,758	1,296	1,300	1,307	1,305	1,303
E3-R1	1,003	1,005	1,003	1,350	1,344	0,999	1,000	1,040	0,962	1,004
E3-R2	0,986	0,988	0,984	1,340	1,334	0,985	0,979	1,024	0,936	0,983
E3-R3	1,020	1,019	1,013	1,361	1,363	1,004	1,006	1,050	0,971	1,015

Tables 1A and 1B. Expected EPS for different compensation-repurchase cases and fixed ESO expiry time $T = 3$. The parameters are as follows in all simulations, except individual parameter values as indicated in the columns: $r = 0.05$, $\mu_s = 0.05$, $\sigma_s = 0.5$, $\mu_p = 0.2$, $\sigma_p = 0.5$, $\rho = 0.5$, $ct = 0.3$, $pt = 0.3$, $t_1 = 2$, $p_c = 3.40$bn, $n = 4.75$bn, $sl = 750$m, $\varphi_1 = 1$, $\varphi_2 = 0.8$. $S_0 = 18$ in Table 1A and $S_0 = 11$ in Table 1B; the option exercise price $K = S_0$. The results are obtained using Monte Carlo simulation with 3.000.000 paths.

Table 2A

Case	$T = 3$	$T = 4$	$T = 5$	$T = 6$
CS	1,016	1,242	1,518	1,854
E1-R1	1,293	1,579	1,927	2,357
E1-R2	1,287	1,572	1,920	2,344
E1-R3	1,304	1,587	1,942	2,363
E2-R1	1,296	1,585	1,934	2,361
E2-R2	1,290	1,574	1,924	2,352
E2-R3	1,309	1,592	1,942	2,372
E3-R1	1,007	1,232	1,502	1,839
E3-R2	0,998	1,217	1,489	1,822
E3-R3	1,016	1,236	1,506	1,841

Table 2B

Case	$T = 3$	$T = 4$	$T = 5$	$T = 6$
CS	1,016	1,241	1,517	1,854
E1-R1	1,285	1,573	1,921	2,348
E1-R2	1,295	1,580	1,929	2,357
E1-R3	1,306	1,590	1,938	2,362
E2-R1	1,292	1,576	1,930	2,356
E2-R2	1,301	1,585	1,937	2,363
E2-R3	1,324	1,601	1,947	2,374
E3-R1	1,002	1,224	1,497	1,829
E3-R2	1,004	1,225	1,494	1,832
E3-R3	1,018	1,237	1,510	1,846

Tables 2A and 2B. Expected EPS for different compensation-repurchase cases and different ESO expiry time T. The parameters are as follows: $r = 0.03$, $\mu_s = 0.05$, $\sigma_s = 0.5$, $\mu_p = 0.2$, $\sigma_p = 0.5$, $r = 0.5$, $ct = 0.3$, $pt = 0.3$, $p_c = 3.40$bn, $n = 4.75$bn, $sl = 750$m, $\varphi_1 = 1$, $\varphi_2 = 0.8$, $t_1 = 2$. $S_0 = 18$ in Table 2A and $S_0 = 11$ in Table 2B; the option exercise price $K = S_0$. The time to expiry T is indicated in the columns. The results are obtained using Monte Carlo simulation with 3.000.000 paths.