Employee share option valuation models

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The widespread adoption of employee share options (ESO) in compensation practice is one of the major recent developments in corporate finance. Although ESO are American call options written by a firm on its own equity, a number of specific contractual features as well as the tax and accounting environment, makes them fairly difficult to value. Selected ESO valuation methods are reviewed below and one of their well-known results, the difference between the model value of the option to the firm and to the employee, is discussed in more detail.

1. Selected ESO pricing methods

Duan and Wei (2005) apply the locally risk-neutral GARCH option pricing model of Duan (1995) to investigate the sensitivity of the ESO value to the systematic risk of the company's stock. The GARCH pricing model allows, in contrast to the Black-Scholes (BS) approach, to include the risk premium parameter in the valuation process. Duan and Wei decompose the risk premium within the framework of the fundamental asset pricing equation of the standard representative agent economy into a form that includes a systematic risk parameter. By holding the total risk constant and changing systematic risk, it is then possible to observe the impact of the systematic risk alone on the option value. Again, this is different from the BS setup where only the effect of the total risk may be studied.

Duan and Wei conduct a numerical comparison of the GARCH and BS values for the options with different maturities and moneyness. The computations are performed for a set of model parameters within ranges obtained from estimating the GARCH model for the Dow Jones component stocks and the S&P500 index for the 1992–2000 period. Their choice of the GARCH model is EGARCH(1,1). The option valuation exercise is then also repeated for the case of index options.

In general, the GARCH model undervalues options with respect to the BS model when the systematic risk is low and overvalues them when the systematic risk is high. In addition, the short-term deep OTM options are undervalued, and the short-term deep ITM options are overvalued by GARCH. The options are more overvalued for higher values of the EGARCH asymmetry parameter. The overvaluation is higher for lower stationary volatilities. Overall, the difference is almost never exceeding 10%. The BS values are higher also for 10-year options with medium systematic risk corresponding to the estimated Dow Jones component values, for a higher stationary volatility parameter.

The results for index options for a particular degree of asymmetry and initial volatility show similar relations between the prices of the two models, although for this kind of options systematic risk is included also in the BS price calculation in the Johnson and Tian (2000) model. Both BS and GARCH prices of index options decrease in value with higher systematic risk. This offsetting effect of the systematic risk on the option value suggests that a portfolio of indexed and non-indexed options may balance ESO holder incentives in the optimal way, a fact which the authors investigate through illustrative combinations in more detail. They offer also some remarks on the possible application of a model in an enviroment with trading restrictions for the holder.

Hall and Murphy (2002) distinguish between the cost of options to the firm and their value to their holders. They define the cost as the BS value of the options. Since, as is well known, a number of assumptions in the BS model is not met by the ESO contract, they set out to compute the value of the option to the recipient. Their model is an economic one, based on the certainty equivalence computation of the sum of cash a risk-averse employee would accept in lieu of options. The model assumptions are based on standard economic theories. The employee is supposed to hold a portfolio of non-firm related wealth invested at the risk-free rate, shares of the firm and ESO. The objective is to compute how much cash must be granted to this employee if he were to hold a cash and stock only portfolio. The amount of cash is computed assuming a power utility for the employee, the CAPM model, and the lognormal distribution of the stock price at option maturity. The parameters for the basic building blocks of the model are chosen at some specific fixed values in illustrative calculations.

Hall and Murphy use their model to compute the incentives provided by the options defined as the sensitivity of the employee ESO value to the share price i.e. the equivalent of the BS delta. They also solve for the ESO exercise price maximizing the incentives at the fixed costs of the firm equal to the BS value of an ESO grant, and also for the case when the constraint on adjusting the cash compensation is relaxed.

Finally, they study the early exercise case in a tree-based approach, where the exercise decision is based on choosing in every node between the expected utility of holding options further and the expected utility of exercising them, selling the shares immediately and investing the proceeds at the risk-free rate until the option maturity.

Hall and Murphy find that the ESO values and incentives in their model are lower than their BS equivalents and that the optimal ESO exercise price is higher for less risk-averse and more diversified employees. They also plot early exercise boundaries for immediately vestable options and observe that the boundary is higher for less risk-averse and more diversified holders. Further, they apply their approach to compute the risk-adjusted pay value for the modified S&P500 CEO sample in the 1992–99 period and compare it to its value based on the standard methodology.

An important problem in valuing option grants is the influence of the outstanding ESO issues on the value of a newly-granted option. Unlike in the standard option pricing case, here the issuer grants usually a large number of options with different characteristics over time and the exercise of options contributes to the earnings dilution, which may become reflected in the stock price. Dennis and Rendleman (2004) investigate such situation in a tree--based model. Various option grants expire at different dates. The underlying stochastic variable is the value of the firm's equity, which is adjusted in every node for the value of options to arrive at the per share equity value treated as the stock price in the exercise decision. The tree includes a binary exercise/no exercise decision variable in addition to the main underlying variable. The valuation problem is solved recursively in a way standard for the path-dependent option pricing taking into account the optimal exercise decisions in every node.

An important limitation of the model is the assumption of the constant strike price for all outstanding options. This strike price is arrived at by recursively computing the price for which the per share value of equity at time zero will equal the strike price. This is unlikely to be true in reality for such an extended period. Further, while the volatility of the equity process is fixed, the standard binomial option prices used for comparison are based on the return statistics implied by price dynamics of the stock from the multiple-grant model.

The authors perform illustrative computations for the two cases with the grant size either of 3% or of 15% of the outstanding time-zero shares, for a fixed time-zero equity value and the number of shares outstanding. They find that the difference between the prices they obtain and the standard approach is relatively unimportant with 3% grants but becomes significant for the admittedly very large 15% grants. Still, the difference depends crucially on the parameters assumed for the standard model. If we price the options with the parameters implied by the ten-year return dynamics, the option price computed with the multiple model is much lower, but if we use one-year average dynamics the multiple-option model produces prices higher than the standard one. This is because the volatility increases with the extension of the returns horizon, and is an effect of diverging dynamics for the share price and for the total equity.

Carpenter (1998) compares two ESO valuation models: an extended American option pricing model and a utility-maximization based one. Since ESO may be exercised by their holder before the expiry date, they clearly include

American features. Since they cannot be adequately hedged and are non-transferable, there exists an optimal exercise policy. In the first of her models Carpenter extends standard American option model by adding an exogenous parameter modeling the stopping rate i.e. the probability of the option exercise or forfeiture before expiry. The optimal option exercise policy is computed in a binomial model, where the option is exercised in a given node either if its payoff is larger than its value in that node or if it is in the random stopping state. In the second model she computes optimal exercise policy for an option holder characterized by a power utility function with a fixed risk-aversion parameter, who holds a certain amount of non-option wealth invested in the Merton bond-and-stock portfolio, and who is given, with a fixed probability at every node, an offer to leave his firm, forfeit the options and receive a certain additional payoff.

Since both models have unknown parameters, the stopping rate in the extended American, as well as the amount of non-firm wealth and the probability of receiving an outside offer and its size in the utility-based model, the author estimates them to match selected empirical characteristics of a sample of option plans for a representative firm. She then computes the model-based characteristics, like average exercise time and stock price at exercise for a number of executive stock options and compares them with the observed data. She also compares her results with the computations based on the application of the standard American option pricing model. The main conclusion is that the extended American model, with only one estimated exogenous parameter produces values very close to the much more complicated utility-based model. Both models, in turn, give option values lower, the exercise time earlier and the stock price at exercise lower than in the standard American model. Using expected exercise time given vesting as the expected option life and expiry time in the BS model and adjusting such BS value by the vesting probability, Carpenter arrives at the GAAP-based value and concludes that in her sample this value matches, or is slightly lower than, the option value in both her models.

2. Incorporating new elements into ESO valuation

The valuation models proposed for employee share options address several main pricing problems. A frequently considered issue is the impact of the restrictive features of the ESO contract (vesting and performance conditions, non-transferability, hedging limitations) on its value to the employee (Hall and Murphy, 2001; Carpenter, 1998). Another topic is the option valuation for inadequately diversified holders (Meulbroeck, 2001). A question shared with the traded option models concerns the selection of the process for the return dynamics of the underlying instrument (Duan and Wei, 2005). A more corporate financial point is the influence of multiple grants and the resulting dilution on the value of the new issues of ESO (Dennis and Rendleman, 2004). The relation between the executive risk taking and the option value is still another issue under study (Duan and Wei, 2005; Hodder and Jackwerth, 2004).

The ESO valuation models may be divided into modified financial models and economic models. Modified financial models are based on the tools well-developed for the traded options with some adjustments introduced to allow for the specific contract features of the ESO. The valuation methods adopted in the current FASB and IASB accounting standards for ESO fall into this category. The economic models frequently employ the certainty equivalence approach or utility-based dynamic programming and take into consideration the impact of employee decision making, preferences and portfolio composition on the option value. Both classes of models are based on a large number of underlying assumptions. In the case of the financial models these include the validity of arbitrage and hedging arguments in the BS setup and the SDF and representative agent valuation approach in the GARCH framework. Various behavioral assumptions are inherent in the utility-based economic models, and some of them also adopt CAPM-related arguments or parameters.

The widely publicized result of many models is the discrepancy between the option cost to the firm, usually understood as the result of a valuation with a financial model, and the option value to the employee usually based on an economic model. This outcome points to an obvious inefficiency. Why should firms compensate their employees with a contract which is valued by them much below the cash equivalent?

It is not impossible that the cost to the firm is in fact lower than that obtained with financial models, or that the value to the employees is higher than that implied by economic models, or that, in general, both types of models might produce through some extensions more compatible results. Two broad lines of investigation, already apparent in some papers, should be pursued further. First, the corporate cost of managing ESO grants as well as the impact of the tax and accounting rules should be incorporated explicitly into the models. The ESO plan details in major technology companies seem to be influenced by different tax, accounting and market regimes (Grabowski, 2005). As is now documented, the ESO-related tax credit has lowered significantly the tax liabilities of US companies in recent years (Graham et al., 2004). Further, companies have modified their payout policies and repurchase strategies in view of their ESO plans. Second, the employee behavioral characteristics adopted in some current models may be misspecified. The executives may adopt excessive risk taking in the firm so that the option value exceeds in some cases their BS value (Duan and Wei, 2005; Hodder and Jackwerth, 2004). The employees may not value options and their company stock in accordance with the standard financial theory and may display over-optimism about the prospects of their firm, and this may result in the overvaluation of options relative to standard models. Further, some option holders may hedge their exposure to a larger extent than assumed in existing specifications. Finally, option grants may be timed in an opportunistic fashion to profit from specific stock market situations (Taranto, 2004; Zhang, 2003). We may hope that further work along these two lines, which may be called, respectively, the transaction cost approach and the behavioral approach, will shed light on some current ESO valuation puzzles and produce tractable models applicable in corporate practice.

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